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Little et al.

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(45) **Date of Patent: Jul. 20, 2010**

(54) **SYSTEM AND METHOD FOR CHECKING DIGITAL CERTIFICATE STATUS**

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H04L 9/32 (2006.01)

(52) **U.S. Cl.** **713/156**; 713/176; 726/10

(58) **Field of Classification Search** 713/176, 713/156

See application file for complete search history.

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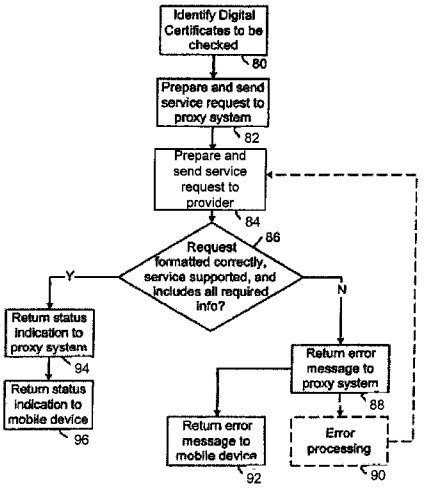
Primary Examiner—Christian LaForgia
(74) *Attorney, Agent, or Firm*—Jones Day; Krishna K. Pathiyal; Robert C. Liang

(57) **ABSTRACT**

A method and system for handling digital certificate status checks are provided. Digital certificate status request data transmitted from a client system is received at a proxy system. The proxy system generates query data for the digital certificate status in response to receiving the digital certificate status request data. The query data is transmitted to a status provider system, and status data from the status provider system in response to the query data is received at the proxy system. Digital certificate status data based on the status data received is generated by the proxy system and transmitted to the client system.

16 Claims, 11 Drawing Sheets



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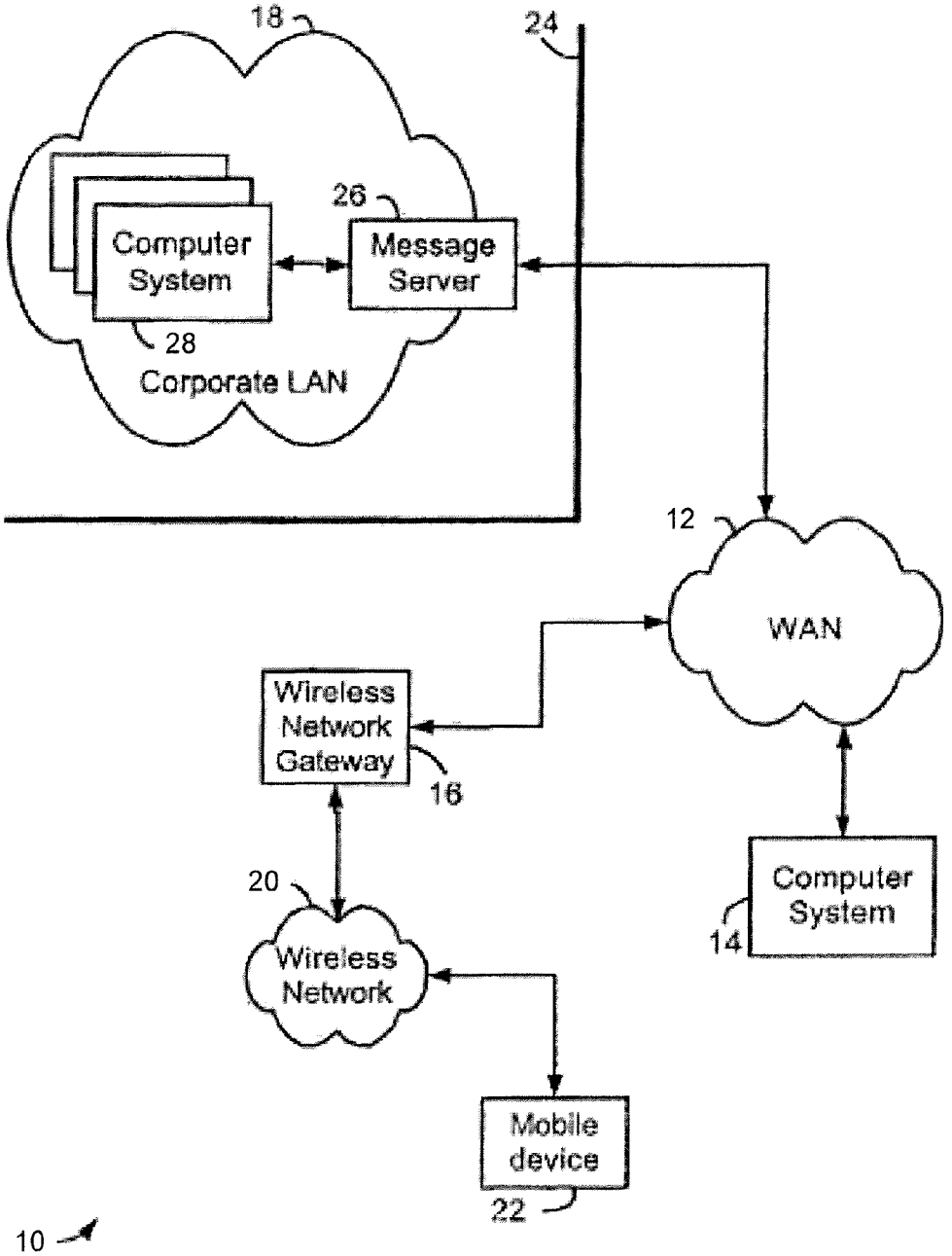
18
24
26
Computer System
Message Server
28
Corporate LAN
12
WAN
Wireless Network Gateway
16
20
Wireless Network
Computer System
14
Mobile device
22
10

FIG. 1

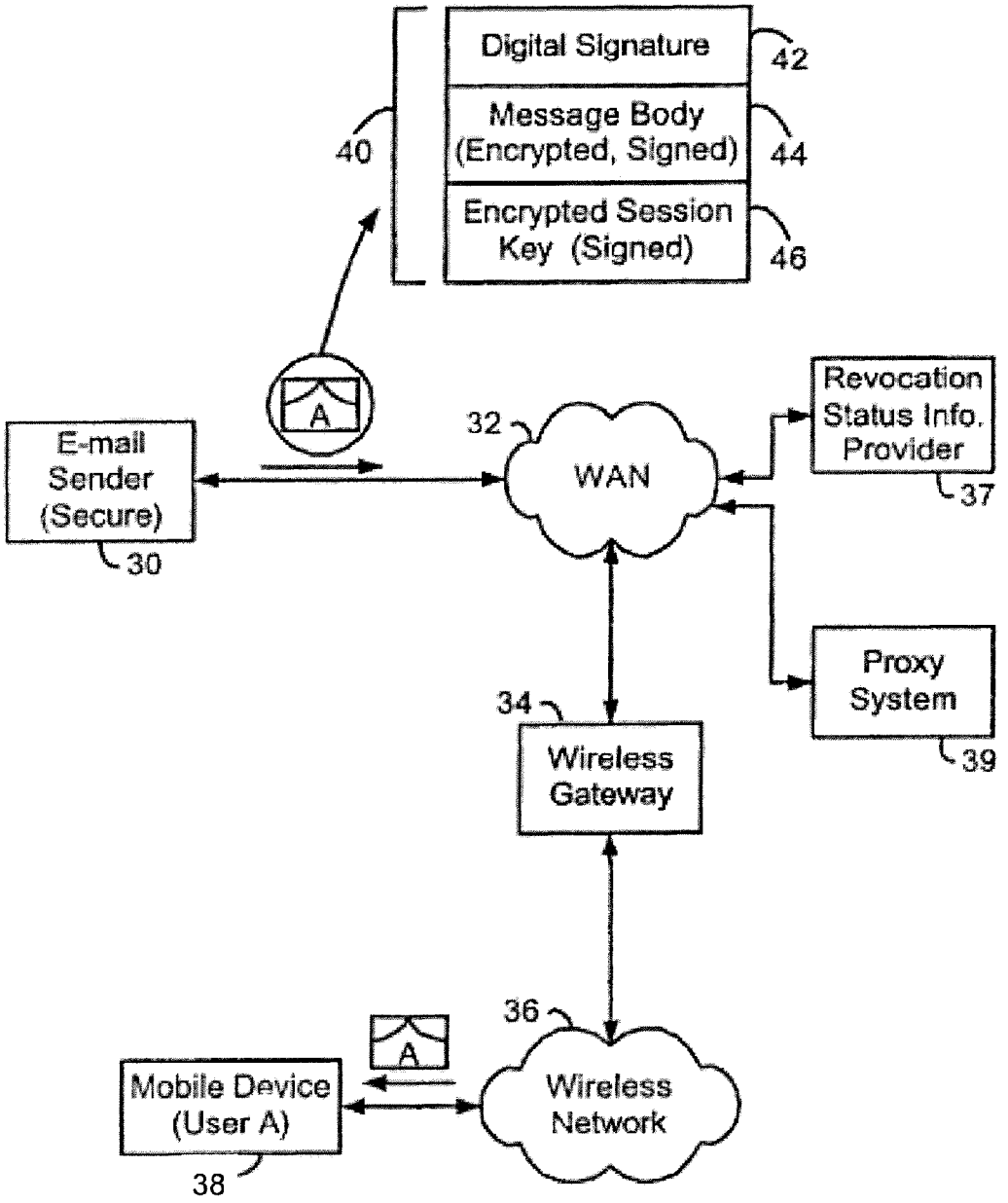
Digital Signature
42
Message Body
(Encrypted, Signed)
44
Encrypted Session
Key (Signed)
46
40
A
E-mail
Sender
(Secure)
30
32
WAN
Revocation
Status Info.
Provider
37
Proxy
System
39
34
Wireless
Gateway
36
A
Mobile Device
(User A)
38
Wireless
Network

FIG. 2

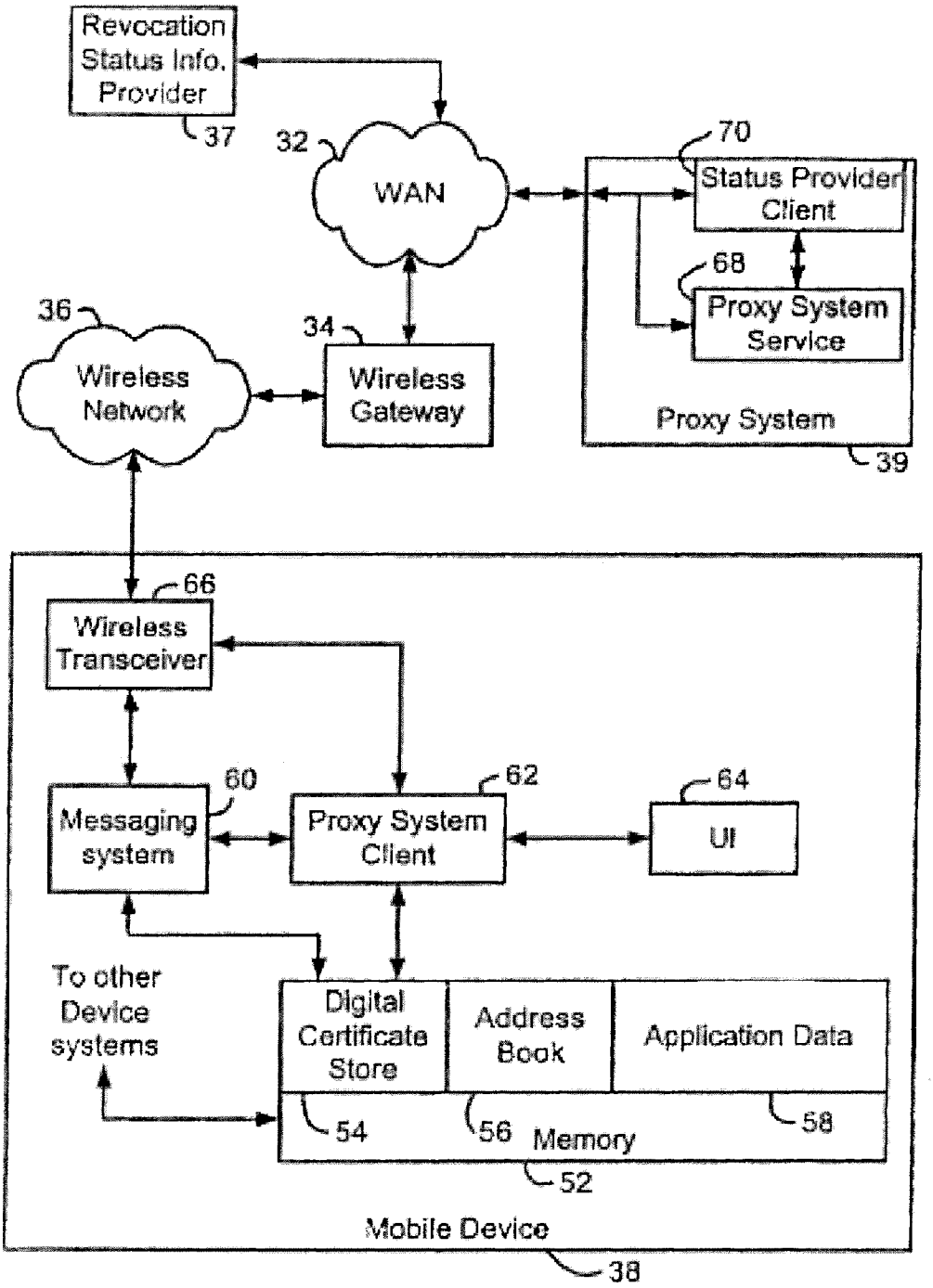
Revocation Status Info. Provider
37
32
WAN
70
Status Provider Client
68
Proxy System Service
Proxy System
39
36
Wireless Network
34
Wireless Gateway
66
Wireless Transceiver
60
Messaging system
62
Proxy System Client
64
UI
To other Device systems
Digital Certificate Store
Address Book
Application Data
54
56
Memory
58
52
Mobile Device
38

FIG. 3

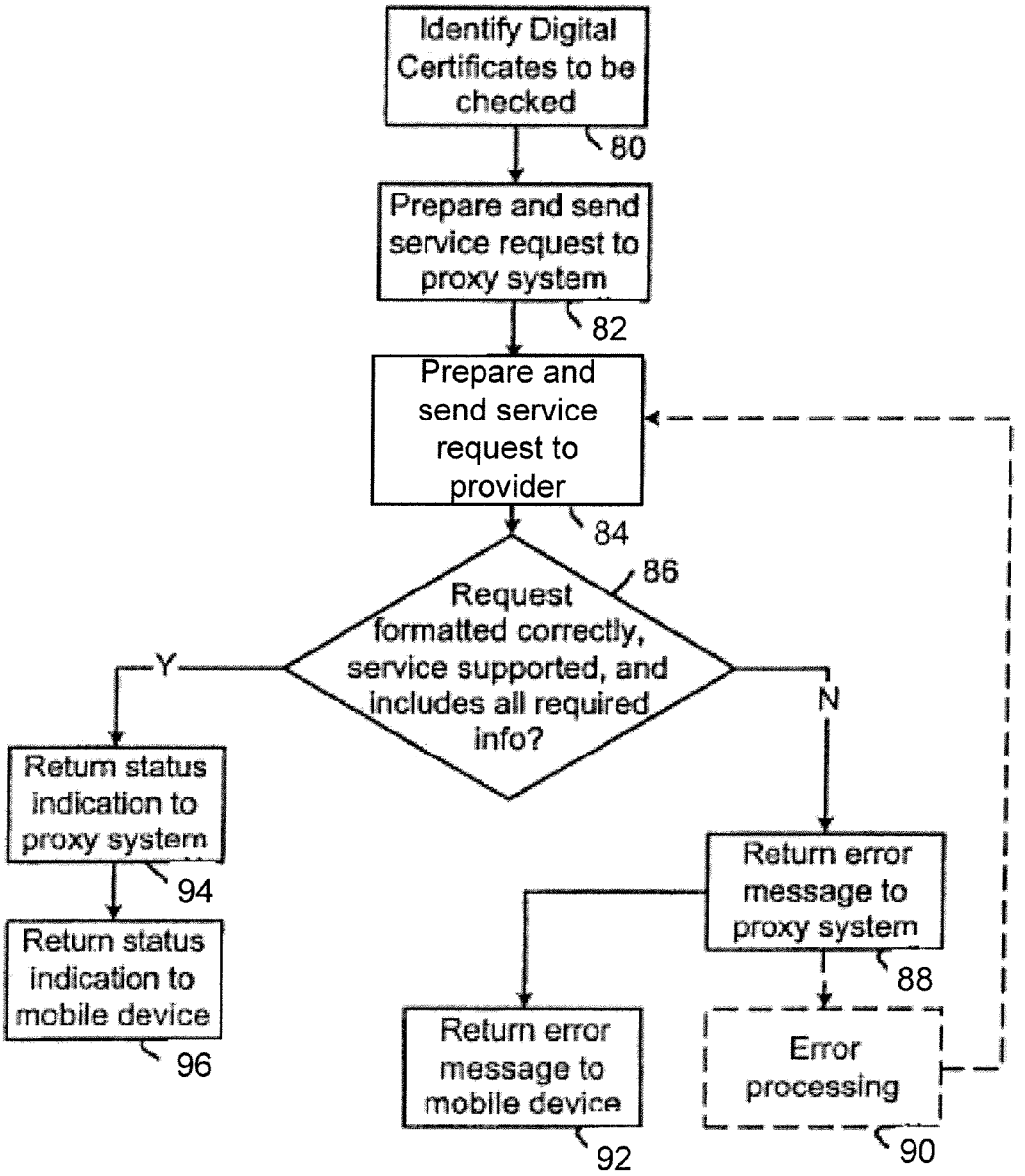
Identify Digital Certificates to be checked
80
Prepare and send service request to proxy system
82
Prepare and send service request to provider
84
86
Request formatted correctly, service supported, and includes all required info?
Y
N
Return status indication to proxy system
94
Return status indication to mobile device
96
Return error message to proxy system
88
Return error message to mobile device
92
Error processing
90

FIG. 4A

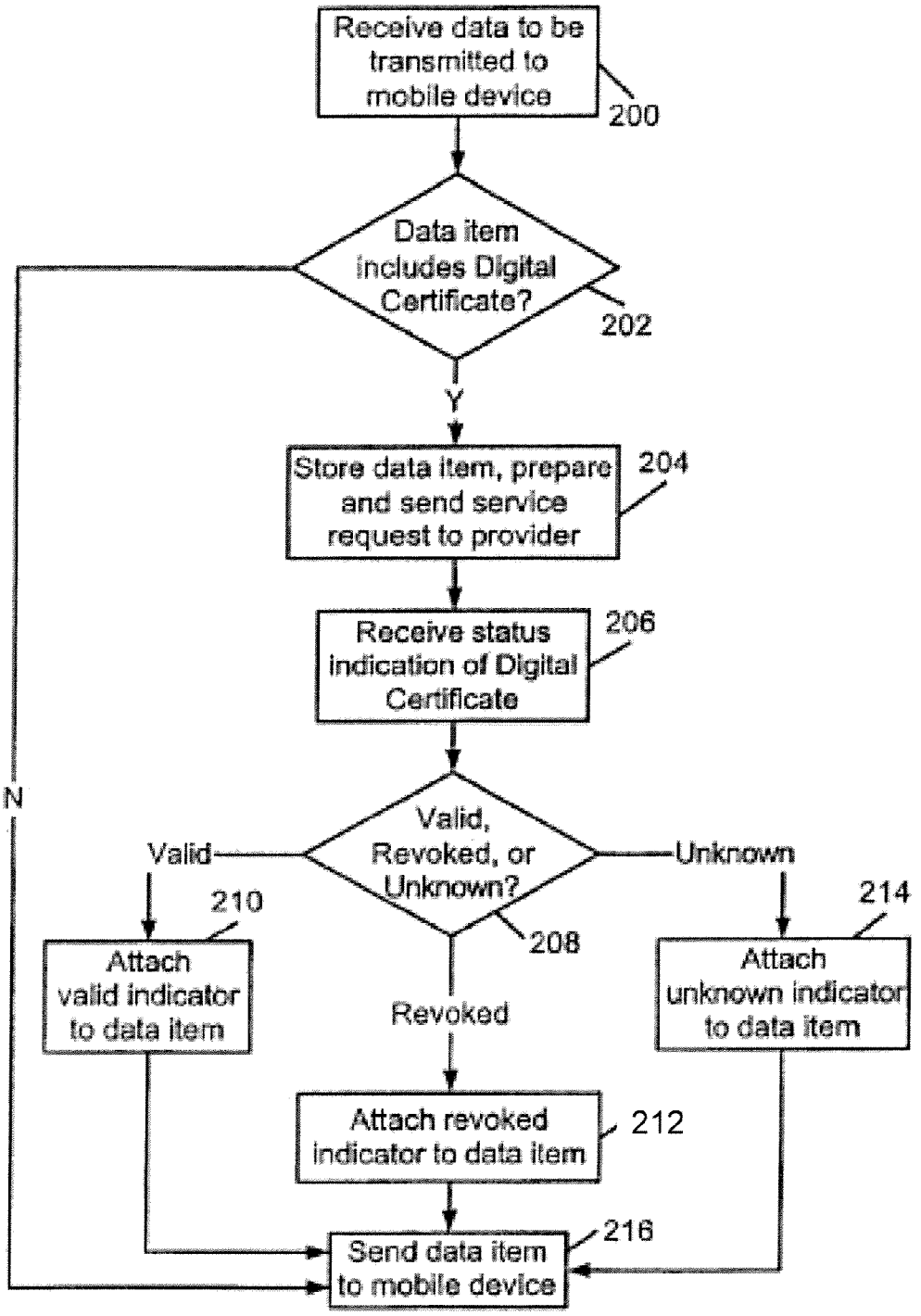
Receive data to be transmitted to mobile device
200
Data item includes Digital Certificate?
202
Y
N
Store data item, prepare and send service request to provider
204
Receive status indication of Digital Certificate
206
Valid, Revoked, or Unknown?
208
Valid
Revoked
Unknown
Attach valid indicator to data item
210
Attach revoked indicator to data item
212
Attach unknown indicator to data item
214
Send data item to mobile device
216

FIG. 4B

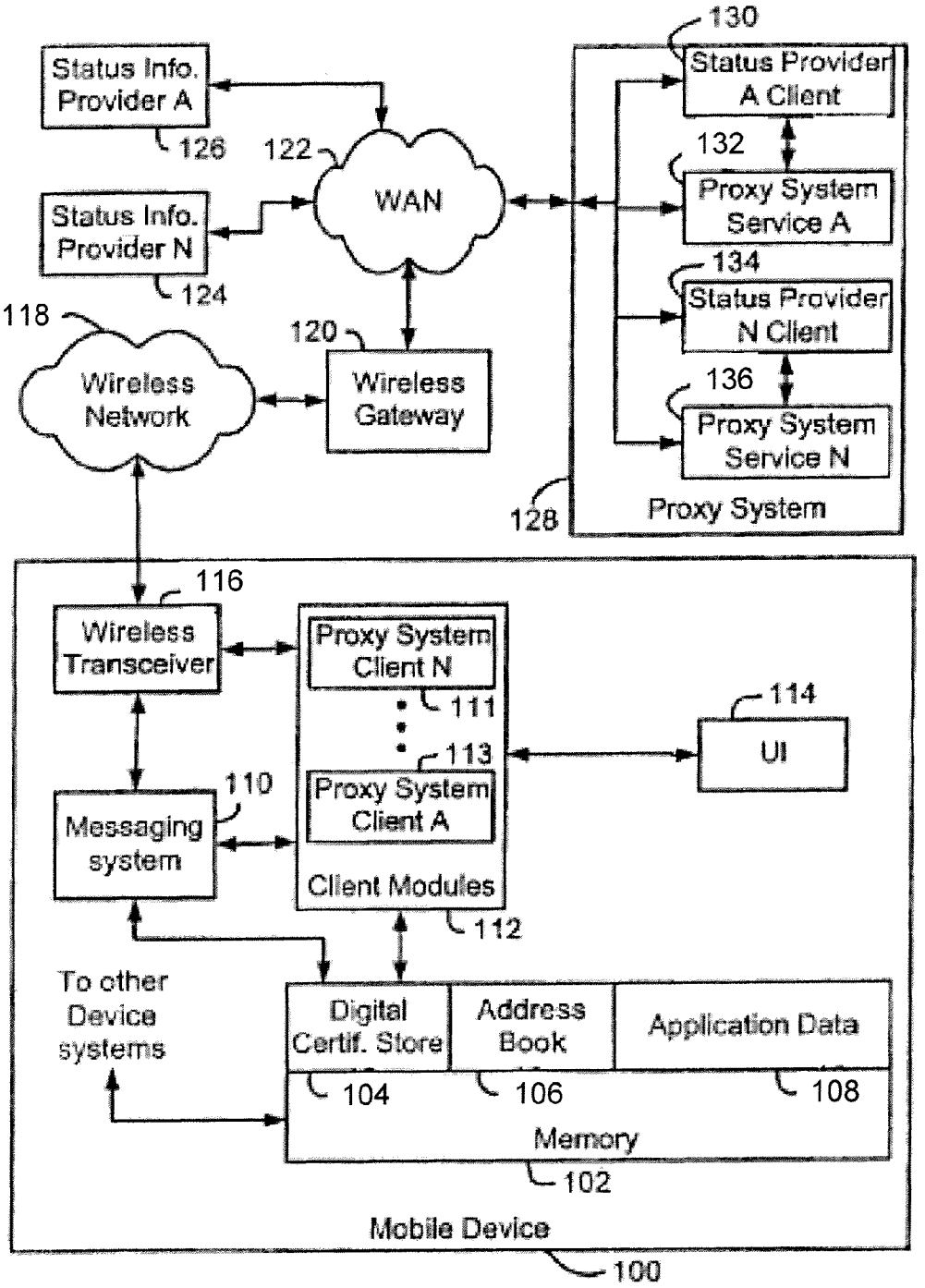
130
Status Info. Provider A
126
122
WAN
Status Provider A Client
132
Proxy System Service A
Status Info. Provider N
124
134
Status Provider N Client
118
120
Wireless Network
Wireless Gateway
136
Proxy System Service N
128
Proxy System
116
Wireless Transceiver
Proxy System Client N
111
114
UI
113
Proxy System Client A
110
Messaging system
Client Modules
112
To other Device systems
Digital Certif. Store
Address Book
Application Data
104
106
108
Memory
102
Mobile Device
100

FIG. 5

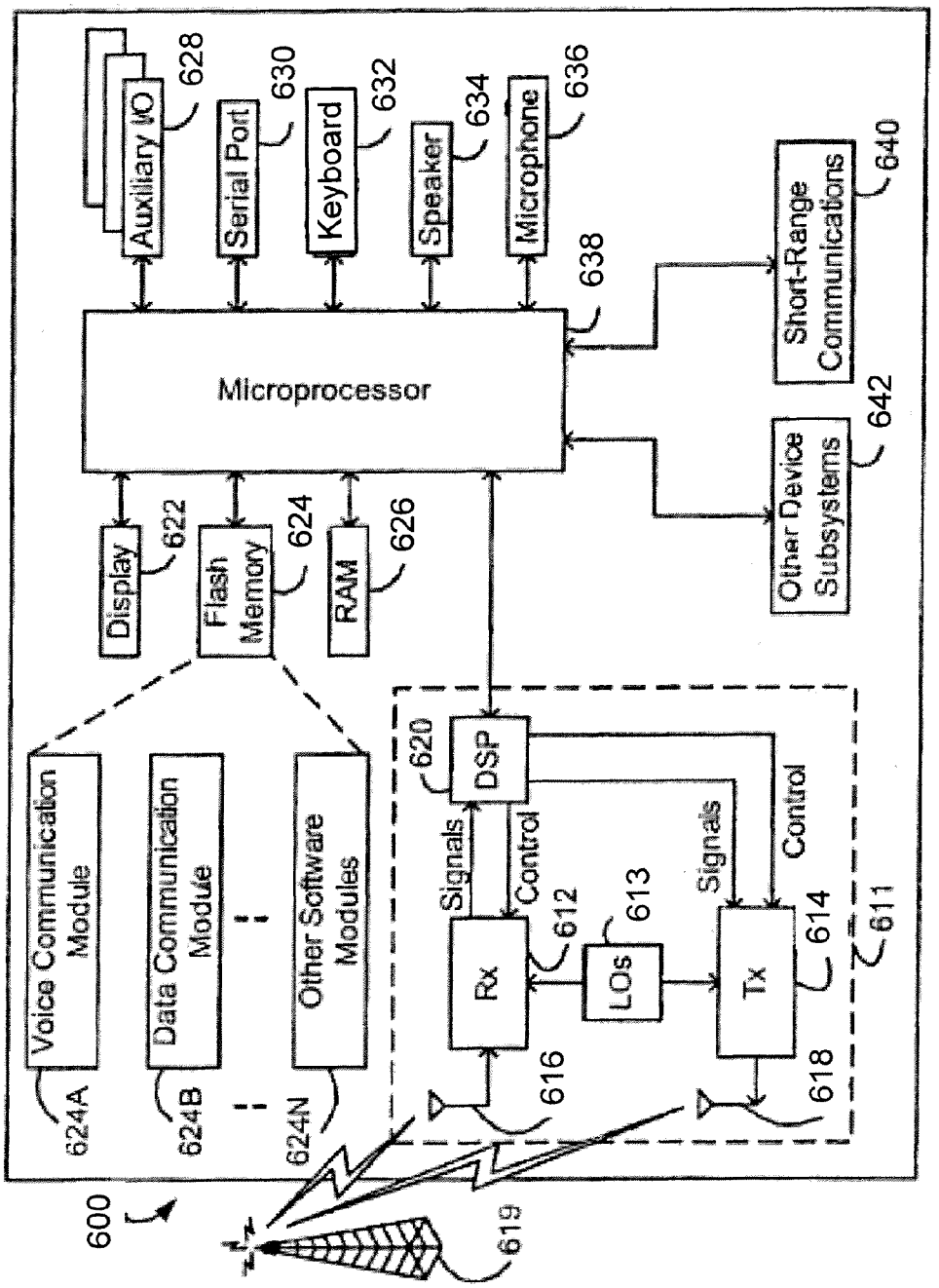
600
619
Voice Communication Module
624A
Data Communication Module
624B
Other Software Modules
624N
Display
622
Flash Memory
624
RAM
626
Microprocessor
638
Auxiliary I/O
628
Serial Port
630
Keyboard
632
Speaker
634
Microphone
636
Short-Range Communications
640
Other Device Subsystems
642
DSP
620
Signals
Control
Rx
612
LOs
613
Tx
614
611
616
618

FIG. 6

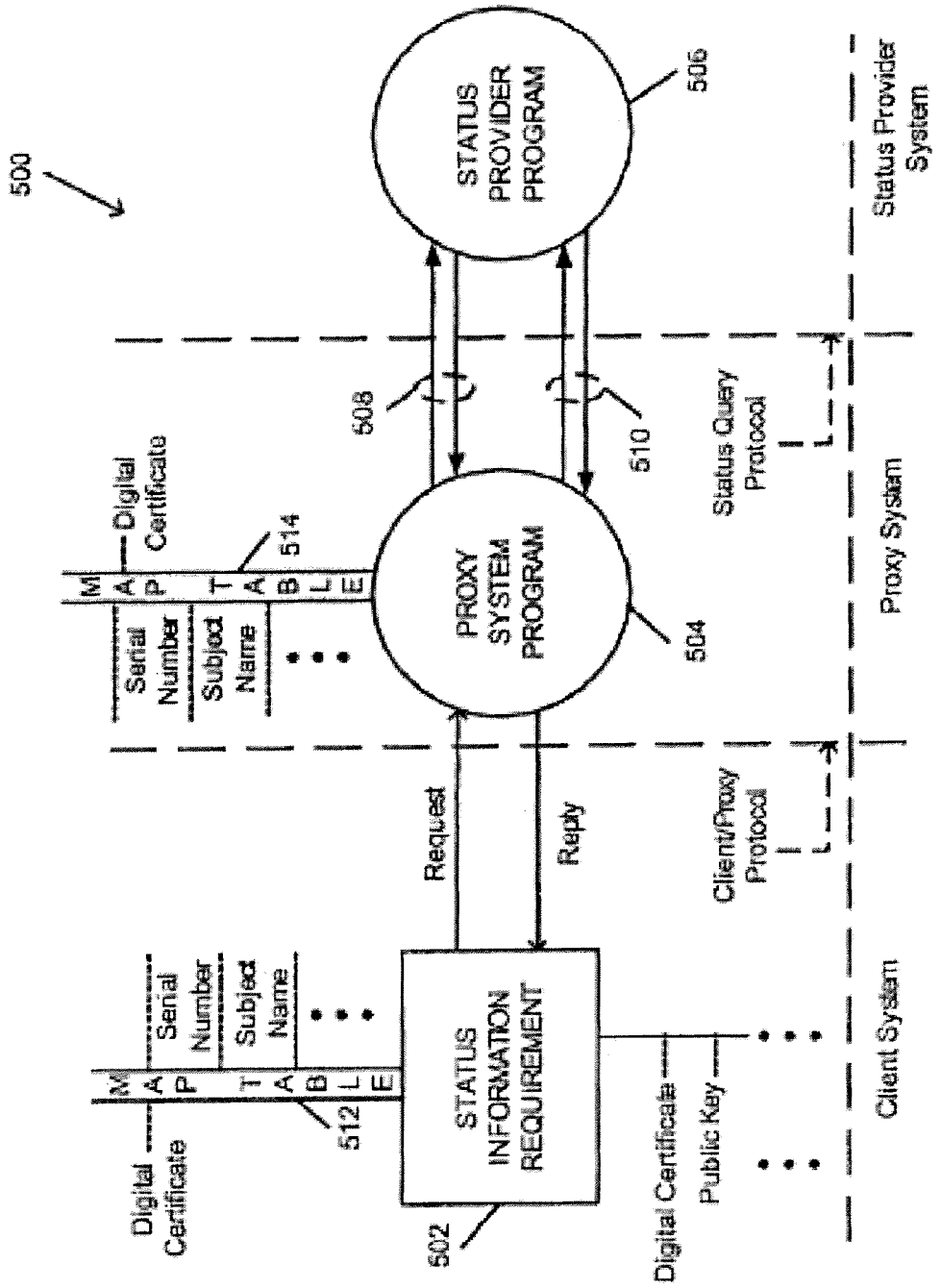
500
STATUS PROVIDER PROGRAM
506
Status Provider System
508
510
Status Query Protocol
PROXY SYSTEM PROGRAM
504
Proxy System
MAP
Digital Certificate
TABLE
514
Serial Number
Subject Name
Request
Reply
Client/Proxy Protocol
STATUS INFORMATION REQUIREMENT
502
512
Digital Certificate
Public Key
Client System

FIG. 7

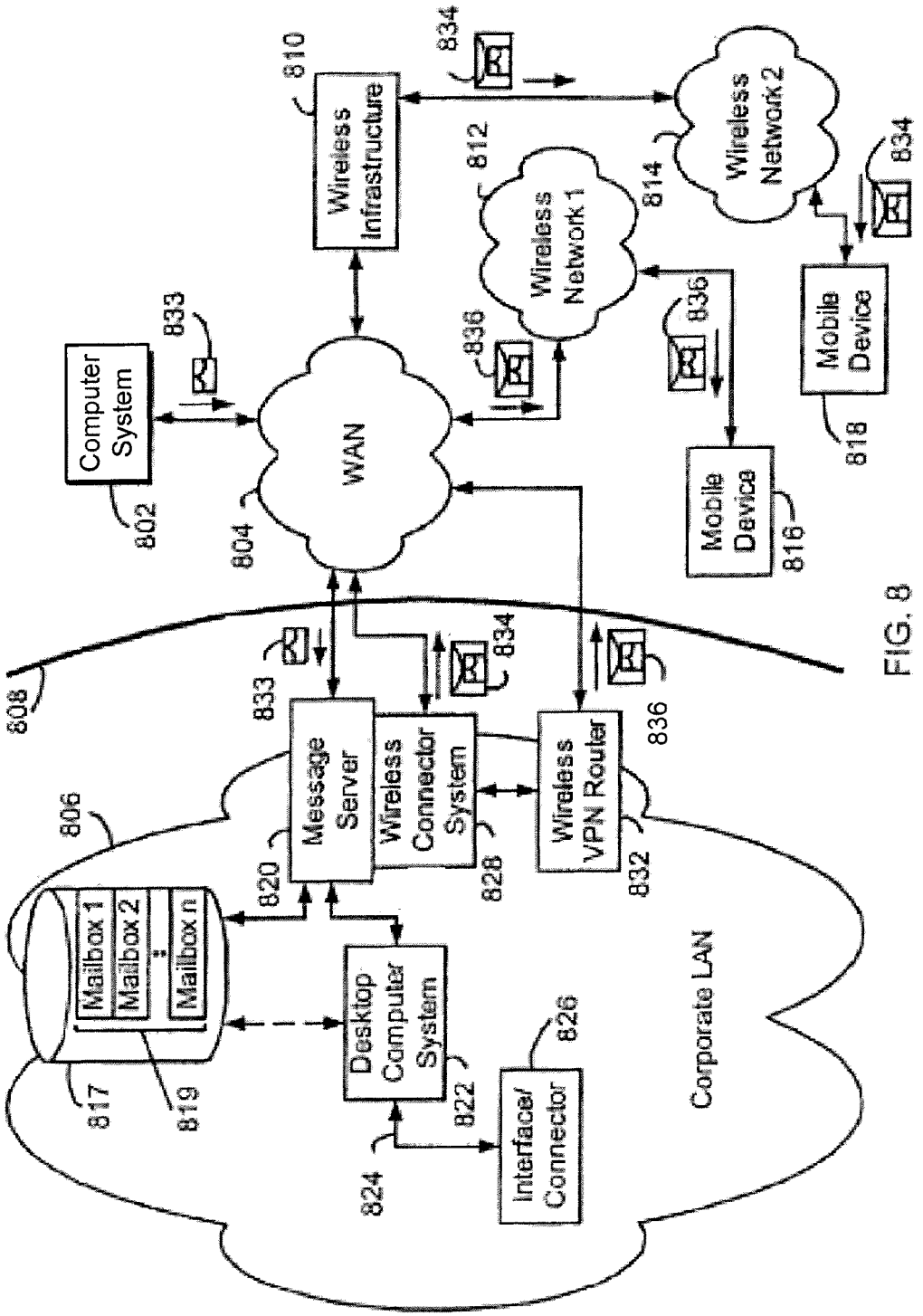
Computer System
802
833
WAN
804
Wireless Infrastructure
810
834
Wireless Network 1
812
Wireless Network 2
814
836
Mobile Device
816
Mobile Device
818
808
Message Server
820
Wireless Connector System
828
Wireless VPN Router
832
806
Mailbox 1
Mailbox 2
Mailbox n
817
819
Desktop Computer System
822
824
Interface/ Connector
826
Corporate LAN

FIG. 8

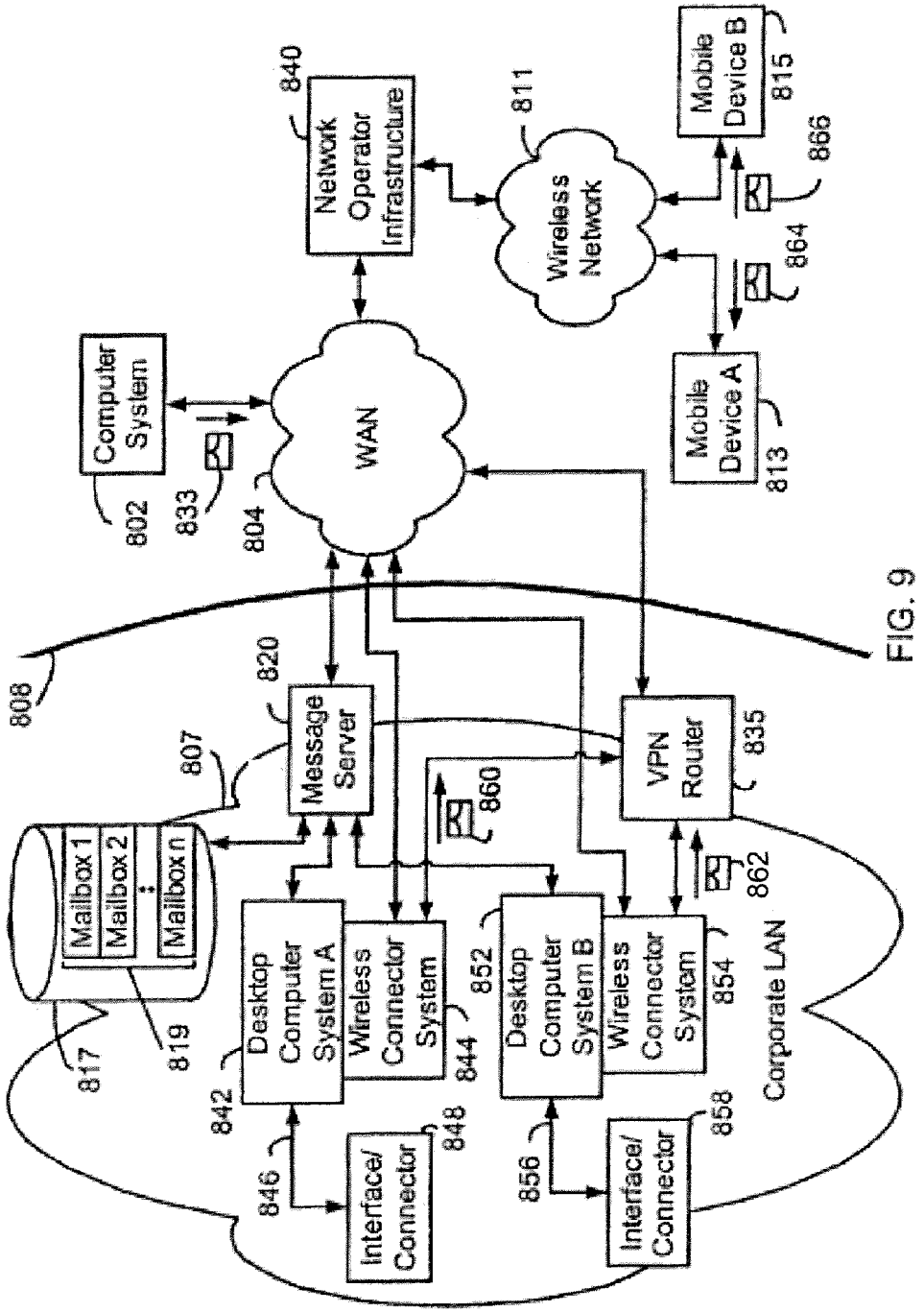
Network Operator Infrastructure
840
Wireless Network
811
Mobile Device B
815
866
864
Computer System
802
833
WAN
804
Mobile Device A
813
808
820
Message Server
807
VPN Router
835
860
862
Mailbox 1
Mailbox 2
Mailbox n
817
819
Desktop Computer System A
842
Wireless Connector System
844
Desktop Computer System B
852
Wireless Connector System
854
Corporate LAN
Interface/ Connector
846
848
Interface/ Connector
856
858

FIG. 9

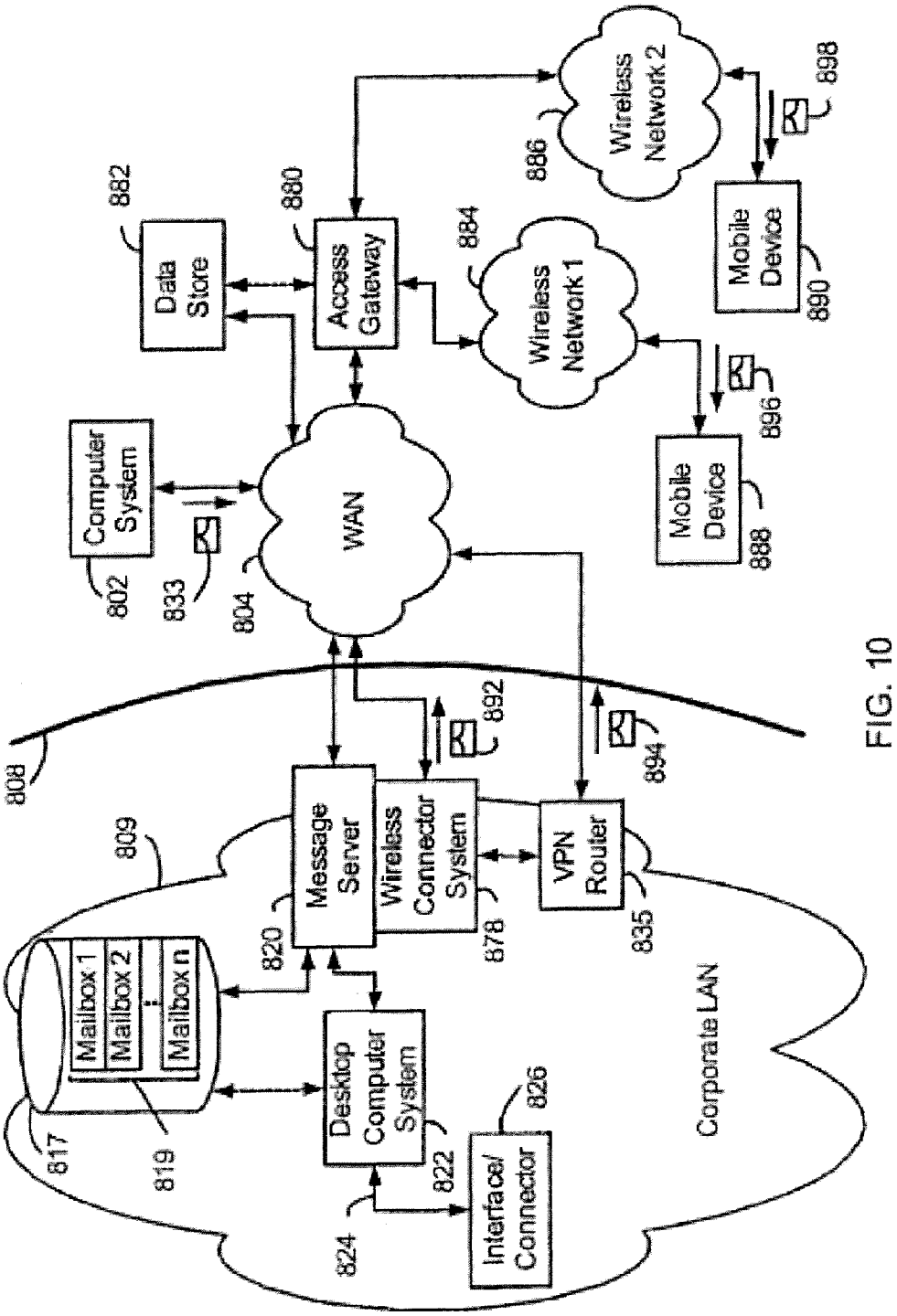
Wireless Network 2
886
898
Mobile Device
890
882
880
884
Data Store
Access Gateway
Wireless Network 1
896
Computer System
802
833
804
WAN
Mobile Device
888
808
892
894
809
Message Server
Wireless Connector System
VPN Router
820
878
835
Mailbox 1
Mailbox 2
Mailbox n
817
819
Desktop Computer System
822
824
826
Interface/ Connector
Corporate LAN

FIG. 10

SYSTEM AND METHOD FOR CHECKING DIGITAL CERTIFICATE STATUS

This application claims the benefit of U.S. Provisional Patent Application Ser. No. 60/365,518, filed Mar. 20, 2002, the entire disclosure of which is incorporated herein by reference.

BACKGROUND

1. Technical Field

This invention relates generally to the field of secure electronic messaging and in particular to checking the status of digital certificates.

2. Description of the State of the Art

Known secure messaging clients including, for example, e-mail software applications operating on desktop computer systems, maintain a data store, or at least a dedicated data storage area, for secure messaging information such as digital certificates. A digital certificate normally includes the public key of an entity as well as identity information that is bound to the public key with one or more digital signatures. In Secure Multipurpose Internet Mail Extensions (S/MIME) messaging, for example, a public key is used to verify a digital signature on a received secure message and to encrypt a session key that was used to encrypt a message to be sent. In other secure messaging schemes, public keys may be used to encrypt data or messages. If a public key is not available at the messaging client when required for encryption or digital signature verification, then the digital certificate is loaded onto the messaging client before these operations can be performed.

Normally, a digital certificate is checked against a Certificate Revocation List (CRL) to determine if the digital certificate has been revoked by its issuer. This check is typically performed when a digital certificate is first received and periodically thereafter, for example, when a new CRL is received. However, CRLs tend to be relatively bulky, so that transfer of CRLs to messaging clients consumes considerable communication resources, and storage of CRLs at a messaging client occupies significant memory space. CRL-based revocation status checks are also processor-intensive and time consuming. These effects can be particularly pronounced in messaging clients operating on wireless mobile communication devices, which operate within bandwidth-limited wireless communication networks and may have limited processing and memory resources. In addition, revocation status is updated in CRL-based systems only when a new CRL is distributed.

One alternative scheme for digital certificate revocation status checking involves querying remote systems that maintain digital certificate revocation status information. This type of scheme requires transfer of less information, reduces the complexity of operations that are performed at a messaging client to check the revocation status of a digital certificate, and may also provide more timely digital certificate revocation status information relative to CRL-based schemes. The Online Certification Status Protocol (OCSP) is an illustrative example of such a scheme. However, wireless communication system bandwidth limitations and latency render these known schemes inappropriate for secure messaging clients operating on wireless mobile communication devices.

SUMMARY

According to an aspect of the invention, a system for determining a status of a digital certificate from status data stored in a status-provider system comprises a client system comprising a client module, the client module operable to generate and provide status request data corresponding to a status request for the digital certificate for transmission from the client system, and to receive digital certificate status data for the digital certificate in response to the status request, and a proxy system comprising a proxy module, the proxy module operable to receive the status request data transmitted from the client system and, in response thereto, generate query data for the digital certificate status and provide the query data for transmission from the proxy system to the status provider system, and further operable to receive the status data from the status provider system, generate the digital certificate status data based on the status data received, and provide the digital certificate status data for transmission to the client system.

In accordance with another aspect of the invention, a system for handling digital certificate status check services for a client system comprises a proxy system comprising a proxy module operable to receive from the client system first digital certificate status check service request data for a digital certificate and, in response thereto, to generate second digital certificate status check service request data and to provide the second digital certificate status check service request data for transmission to a digital certificate status check service provider system, and further operable to receive first digital certificate status check service data from the digital certificate status check service provider system, to generate second digital certificate status check service data based on the first digital certificate status check service data received, and to provide the second digital certificate status check service data for transmission to the client system, wherein the second digital certificate status check service data comprises a subset of the first digital certificate status check service data received from the service provider system.

A system for handling digital certificate status check services for a digital certificate, the digital certificate status check services provided by a digital certificate status check service provider system operable to receive query data for a digital certificate status check service request, in another embodiment of the invention, comprises a client system comprising a client module operable to prepare and provide for transmission first digital certificate status check service request data corresponding to a digital certificate status check service for a digital certificate, and to receive first digital certificate status check service data in response to the first digital certificate status check service request data, wherein the first digital certificate status check service request data comprises a subset of the query data for a digital certificate status check service request.

A method for handling digital certificate status check services for. a digital certificate, the digital certificate status check services provided by a digital certificate status check service provider system operable to receive query data for a digital certificate status check service request, according to a further aspect of the invention comprises the steps of receiving a data item, determining whether the data item comprises a digital certificate, generating digital certificate status check service request data comprising a subset of the query data where the data item comprises a digital certificate, providing the digital certificate status check service request data for transmission to a proxy system, and receiving digital certificate status check service data from the proxy system in response to the digital certificate status check service request data.

In a still further embodiment of the invention, a method for handling digital certificate status requests between a client

system and a proxy system comprises the steps of receiving at the proxy system digital certificate status request data transmitted from the client system, generating query data for the digital certificate status in response to receiving the digital certificate status request data, transmitting the query data to a status provider system, receiving at the proxy system status data from the status provider system in response to the query data, generating digital certificate status data based on the status data received, and transmitting the digital certificate status data to the client system.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a block diagram of an exemplary messaging system.

FIG. **2** is a block diagram illustrating a secure e-mail message exchange in a messaging system.

FIG. **3** is a block diagram of a system implementing a digital certificate revocation status check system.

FIG. **4**A is a flow diagram illustrating a method of checking digital certificate revocation status.

FIG. **4**B is a flow diagram illustrating another method of checking digital certificate revocation status.

FIG. **5** is a block diagram of a system implementing a digital certificate revocation status check system having multiple proxy system client modules.

FIG. **6** is a block diagram of a wireless mobile communication device.

FIG. **7** is a functional block diagram illustrating the processing of a digital certificate status request.

FIG. **8** is a block diagram showing a communication system.

FIG. **9** is a block diagram of an alternative communication system.

FIG. **10** is a block diagram of another alternative communication system.

DETAILED DESCRIPTION

A secure message is a message that has been processed by a message sender, or possibly an intermediate system between a message sender and a message receiver, to ensure one or more of data confidentiality, data integrity and user authentication. Common techniques for secure messaging include signing a message with a digital signature and/or encrypting a message. For example, a secure message may be a message that has been signed, encrypted, encrypted and then signed, or signed and then encrypted, according to variants of Secure Multipurpose Internet Mail Extensions (S/MIME).

A messaging client allows a system on which it operates to receive and possibly also send messages. Messaging clients may operate on a computer system, a handheld device, or any other system or device with communications capabilities. Many messaging clients also have additional non-messaging functions.

FIG. **1** is a block diagram of an exemplary messaging system. The system **10** includes a Wide Area Network (WAN) **12**, coupled to a computer system **14**, a wireless network gateway **16** and a corporate Local Area Network (LAN) **18**. The wireless network gateway **16** is also connected to a wireless communication network **20** in which a wireless mobile communication device **22** ("mobile device"), is configured to operate.

An exemplary mobile device **22** is the type disclosed in U.S. Pat. No. 6,278,442, entitled "HAND-HELD ELECTRONIC DEVICE WITH A KEYBOARD OPTIMIZED FOR USE WITH THE THUMBS," the entire disclosure of which is incorporated herein by reference. The computer system **14** is a desktop or laptop PC, which is configured to communicate to the WAN **12**. WAN **12** may be a large network, such as the Internet, for example. PCs, such as computer system **14**, normally access the Internet through an Internet Service Provider (ISP), Application Service Provider (ASP), or the like.

The corporate LAN **18** is illustratively a network-based messaging client, located behind a security firewall **24**. Within the corporate LAN **18**, a message server **26**, operating on a computer behind the firewall **24**, functions as the primary interface for the corporation to exchange messages both within the LAN **18**, and with other external messaging clients via the WAN **12**. Two exemplary message servers **26** are Microsoft™ Exchange Server and Lotus Domino™. These servers are often used in conjunction with Internet mail routers to route and deliver mail. The message server **26** may also provide additional functionality, such as dynamic database storage for data related to calendars, to-do lists, task lists, e-mail and documentation.

The message server **26** provides messaging capabilities to networked computer systems **28** coupled to the LAN **18**. A typical LAN **18** includes multiple computer systems **28**, each of which implements a messaging client, such as Microsoft Outlook™, Lotus Notes™, etc. Within the LAN **18**, messages are received by the message server **26**, distributed to the appropriate mailboxes for user accounts addressed in the received messages, and are then accessed by a user through a messaging client operating on a computer system **28**.

The wireless network gateway **16** provides an interface to a Wireless network **20**, through which messages are exchanged with the mobile device **22**. The mobile device **22** may, for example, comprise a data communication device, a voice communication device, a dual-mode communication device such as a mobile telephone having both data and voice communications functionality, a personal digital assistant (PDA) enabled for wireless communications, or a wireless modem operating in conjunction with a laptop or desktop computer system or some other device. An exemplary mobile device **22** is previously described, and as described further with reference to FIG. **6**.

Such functions as addressing of the mobile device **22**, encoding or otherwise transforming messages for wireless transmission, and any other required interface functions may be performed by the wireless network gateway **16**. The wireless network gateway **16** may be configured to operate with more than one wireless network **20**, in which case the wireless network gateway **16** also determines a most likely network for locating a given mobile device user and possibly tracks mobile devices as users roam between countries or networks.

Any computer system with access to the WAN **12** may exchange messages with the mobile device **22** through the wireless network gateway **16**. Alternatively, private wireless network gateways such as wireless Virtual Private Network (VPN) routers could also be implemented to provide a private interface to a wireless network. For example, a wireless VPN implemented in the LAN **18** may provide a private interface from the LAN **18** to one or more wireless mobile devices such as **22** through the wireless network **20**. Such a private interface to wireless mobile devices via the wireless network gateway **16** and/or the wireless network **20** is effectively extended to entities outside the LAN **18** by providing a message forwarding or redirection system that operates with the message server **26**. In this type of system, incoming messages received by the message server **26** and addressed to a mailbox or data store associated with a user of a mobile device such as

22 are sent through the wireless network interface, either a wireless VPN router, the wireless network gateway **16**, or another interface, for example, to the wireless network **20** and to the users mobile device **22**. Another exemplary redirector system operating on the message server **26** may be of the type disclosed in U.S. Pat. No. 6,219,694, entitled "SYSTEM AND METHOD FOR PUSHING INFORMATION FROM A HOST SYSTEM TO A MOBILE DATA COMMUNICATION DEVICE HAVING A SHARED ELECTRONIC ADDRESS," the entire disclosure of which is incorporated herein by reference.

Another alternate interface to a user's mailbox on a message server **26** is a Wireless Application Protocol (WAP) gateway. Through a WAP gateway, a list of messages in a user's mailbox on the message server **26**, and possibly each message or a portion of each message, may be sent to the mobile device **22**.

A wireless network normally delivers messages to and from mobile devices via RF transmissions between base stations in the wireless network and the mobile devices. The wireless network **20** may, for example, be a data-centric wireless network, a voice-centric wireless network, or a dual-mode network that can support both voice and data communications over the same infrastructure. Illustrative wireless networks include the Code Division Multiple Access (CDMA) network, the Groupe Special Mobile or the Global System for Mobile Communications (GSM) and the General Packet Radio Service (GPRS), and third-generation (3G) networks such as the Enhanced Data rates for Global Evolution (EDGE) and Universal Mobile Telecommunications Systems (UMTS). GPRS is a data-centric that is a data overlay on top of the existing GSM wireless network.

Some older examples of data-centric network include, but are not limited to: the Mobitex™ Radio Network ("Mobitex"), and the DataTAC™ Radio Network ("DataTAC"). Examples of voice-centric data networks include Personal Communication Systems (PCS) networks like CDMA, GSM, and Time Division Multiple Access (TDMA) systems that have been available for several years.

Perhaps the most common type of messaging currently in use is e-mail. In a standard e-mail system, an e-mail message is sent by an e-mail sender, possibly through a message server and/or a service provider system, and typically routed through the Internet to one or more message receivers. E-mail messages are normally sent in the clear and use traditional Simple Mail Transfer Protocol (SMTP), RFC822 headers and MIME body parts to define the format of the e-mail message.

In recent years, secure messaging techniques have evolved to protect both the content and integrity of messages such as e-mail messages. S/MIME and Pretty Good Privacy™ (PGP™) are two public key secure e-mail messaging protocols that provide for both encryption and signing, which protects the integrity of a message and provides for sender authentication by a message receiver. Secure messages may also be encoded, compressed or otherwise processed in addition to being encrypted and/or signed.

FIG. **2** is a block diagram illustrating a secure e-mail message exchange in a messaging system. The system includes an e-mail sender **30**, coupled to a WAN **32** and a wireless gateway **34**, which provides an interface between the WAN **32** and a wireless network **36**. A mobile device **38** is adapted to operate within the wireless network **36**. Also shown in FIG. **2** are a digital certificate revocation status information provider **37** and a proxy system **39**, both connected to the WAN **32**.

The e-mail sender **30** is a PC, such as the system **14** in FIG. **1**, a network-connected computer, such as the computer system **28** or FIG. **1**, or another mobile device on which an e-mail message A is composed and sent. The WAN **32**, the wireless gateway **34**, the wireless network **36**, and the mobile device **38** are substantially the same as similarly labelled components in FIG. **1**.

According to secure messaging schemes such as S/MIME and PGP, a message is encrypted using a one-time session key chosen by the e-mail sender **30**. The session key is used to encrypt the message body and is then itself encrypted using the public key of each addressed message receiver to which the message is to be sent. As shown at **40**, a message encrypted in this way includes an encrypted message body **44** and an encrypted session key **46**. In this type of message encryption scheme, a message sender such as the e-mail sender **30** must have access to the public key of each entity to which an encrypted message is to be sent.

According to one known digital signature scheme, the secure e-mail sender **30** signs a message by taking a digest of the message and signing the digest using the sender's private key. A digest may, for example, be generated by performing a check-sum, Cyclic Redundancy Check (CRC) or some other preferably non-reversible operation such as a hash on the message. This digest is then signed by the sender using the sender's private key. The private key may be used to perform an encryption or other transformation operation on the digest to generate the digest signature. A digital signature including the digest and the digest signature is then appended to the outgoing message. In addition, a digital certificate of the sender **30**, which includes the sender's public key and sender identity information that is bound to the public key with one or more digital signatures, and possibly any chained digital certificates and CRLs associated with the sender's digital certificate and any chained digital certificates, may also be attached to a secure message.

The secure e-mail message **40** sent by the e-mail sender **30** includes the digital signature **42**, as well as the encrypted message body **44** and the encrypted session key **46**, both of which are signed. The sender's digital certificate, any chained digital certificates, and one or more CRLs may also be included in the message **40**. In the S/MIME secure messaging technique, digital certificates, CRLs and digital signatures are normally placed at the beginning of a message, and the message body is included in a file attachment. Messages generated by other secure messaging schemes may place message components in a different order than shown or include additional and/or different components. For example, a secure message **40** may include addressing information, such as "To:" and "From:" e-mail addresses, and other header information.

When the secure e-mail message **40** is sent from the e-mail sender **30**, it is routed through the WAN **32** and the wireless gateway **34** to the wireless network **36** and the mobile device **38**. The transmission path between the e-mail sender **30** and the mobile device **38** may also include additional or different components than those shown in FIG. **2**. For example, the secure e-mail message **40** may be addressed to a mailbox or data store associated with a message server or data server which has been wirelessly enabled to forward or send received messages and data to the mobile device **38**. Further intermediate systems may also store and/or route the secure message to the mobile device **38**. The exemplary redirection system as previously described and as disclosed in U.S. Pat. No. 6,219,694 is an example of one such system.

In addition, the message may be routed or forwarded to the mobile device **38** through other transport mechanisms than the wireless gateway **34**. For example, routing to the wireless network **36** may be accomplished using a wireless VPN router associated with the e-mail sender **30**, or, in the case of

a message being received at an intermediate computer system or server and then forwarded to the mobile device **38**, with the intermediate computer system or server.

Regardless of whether a signed message is sent directly to the mobile device **38** or redirected to the mobile device **38**, when a signed message is received, the mobile device **38** may verify the digital signature **42** by generating a digest of the message body **44** and encrypted session key **46**, extracting the digest from the digital signature **42**, comparing the generated digest with the digest extracted from the digital signature **42**, and verifying the digest signature in the digital signature **42**. The digest algorithm used by a secure message receiver is the same as the algorithm used by the message sender, and may be specified, for example, in a message header or possibly in the digital signature **42**. One commonly used digest algorithm is the so-called Secure Hashing Algorithm 1 (SHA1), although other digest algorithms such as Message-Digest Algorithm 5 (MD5) may also be used.

In order to verify the digest signature **42**, a message receiver retrieves the sender's public key and verifies the signature on the digest in the digital signature **42** by performing a reverse transformation on the digest signature. For example, if the message sender generated the digest signature by encrypting the digest using the sender's private key, then a receiver uses the sender's public key to decrypt the digest signature to recover the original digest. If a secure message includes the sender's digital certificate or the sender's digital certificate has already been stored in a data store at the mobile device **38**, then the sender's public key is extracted from the received or stored digital certificate. The sender's public key may instead be retrieved from a local store if the public key was extracted from an earlier message from the sender and stored in a key store in the receiver's local store. Alternatively, the sender's digital certificate may be requested from a Public Key Server (PKS). A PKS is a server that is normally associated with a Certificate Authority (CA) from which a digital certificate for an entity, including the entity's public key, is available. A PKS might reside within a corporate LAN such as **18** (FIG. **1**), or anywhere on the WAN **32**, Internet or other network or system through which message receivers may establish communications with the PKS. A sender's digital certificate may also possibly be loaded onto a mobile device **38** from a PC or other computer system.

A digest algorithm is preferably a non-reversible function that produces a unique output for every unique input. Therefore, if an original message is changed or corrupted, then the digest generated by the receiver will be different from the digest extracted from the digital signature, and signature verification therefore fails. Because digest algorithms are publicly known, however, it is possible that an entity may alter a secure message, generate a new digest of the altered message, and forward the altered message to any addressed message receivers. In this case, the digest generated at the receiver on the basis of the altered message will match the new digest that was added by the entity that altered the message. The digest signature check is intended to prevent verification of a digital signature in such a situation. Even though the generated and new digests will match, since a sender signs the original digest using its own private key, the entity that altered the message cannot generate a new digest signature that can be verified with the sender's public key. Therefore, although the digests in the altered message match, the digital signature will not be verified since the digest signature verification will fail.

These mathematical operations do not prevent anyone from seeing the contents of the secure message, but do ensure the message has not been tampered with since it was signed by the sender, and that the message was signed by the person as indicated on the 'From' field of the message.

It should also be appreciated that other digital signature generation and verification algorithms may instead be used. The digest and reverse transform scheme described above is one example of a digital signature scheme. The present invention is in no way limited thereto.

When the digital signature **42** has been verified, or sometimes even if digital signature verification fails, the encrypted message body **44** is then decrypted before it is displayed or further processed by a receiving messaging client operating on the mobile device **38** in FIG. **2**. A receiving messaging client uses its private key to decrypt the encrypted session key **46** and then uses the decrypted session key to decrypt the encrypted message body **44** and thereby recover the original message.

An encrypted message that is addressed to more than one receiver includes an encrypted version of the session key, for each receiver, that is encrypted using the public key of the receiver. Each receiver performs the same digital signature verification operations, but decrypts a different one of the encrypted session keys using its own private key.

Therefore, in a secure messaging system, a sending messaging client must have access to the public key of any receiver to which an encrypted message is to be sent. A receiving messaging client must be able to retrieve the sender's public key, which may be available to a messaging client through various mechanisms, in order to verify a digital signature in a signed message. Although the mobile device **38** is a receiver of the secure message **40**, the mobile device **38** may be enabled for two-way communications, and may therefore require public keys for both message sending and message receiving operations.

Public keys are commonly provided in digital certificates. As described above, a digital certificate for any particular entity typically includes the entity's public key and identification information that is bound to the public key with a digital signature. Several types of digital certificates are currently in widespread use, including, for example, X.509 digital certificates, which are typically used in S/MIME. PGP uses digital certificates with a slightly different format. The systems and methods as disclosed herein may be used with any of these types of digital certificates, as well as other types of digital certificates, both currently known types as well as others that are developed in the future.

The digital signature in a digital certificate is generated by the issuer of the digital certificate, and can be checked by a message receiver. A digital certificate sometimes includes an expiry time or validity period from which a messaging client determines if the digital certificate has expired. Verification of the validity of a digital certificate may also involve tracing a certification path through a digital certificate chain, which includes a user's digital certificate as well as possibly other digital certificates to verify that the user's digital certificate is authentic.

A digital certificate may also be checked to ensure that it has not been revoked. As described above, digital certificate revocation status may be checked by consulting a CRL or by requesting digital certificate status information from a digital certificate revocation status information source. In the system of FIG. **2**, a user of the mobile device **38** may submit a revocation status request for any digital certificate stored at the mobile device **38** to the revocation status information provider **37**. The provider **37** then returns revocation status information for that digital certificate to the mobile device **38**.

OCSP is one scheme that provides for determination of digital certificate revocation status without requiring CRLs.

Versions of OCSP have been defined, for example, in RFC 2560 and in the Internet-Draft "Online Digital Certificate Status Protocol, version 2", both available from the Internet Engineering Task Force (IETF). OCSP is one of the most widely used digital certificate revocation status check protocols and is therefore used herein as an illustrative example of such schemes. The systems and methods described herein, however, are also applicable to other types of digital certificate revocation status checking schemes involving retrieval of revocation status information from remote sources.

According to OCSP, a request is submitted to a status information provider, generally referred to as an OCSP responder. Upon receipt of a properly formatted request, an OCSP responder returns a response to the requestor. An OCSP request includes at least an OCSP protocol version number, a service request, and an identification of a target digital certificate to which the request is related.

The version number identifies the version of OCSP with which the request complies. The service request specifies the type of service being requested. For OCSP version 2, Online Revocation Status (ORS), Delegated Path Validation (DPV) and Delegated Path Discovery (DPD) services have been defined. Through the ORS service, a messaging client obtains revocation status information for digital certificates. The DPV and DPD services effectively delegate digital certificate validation path-related processing to a remote system.

Normally, a target digital certificate is identified in an OCSP request using a hash of the distinguished name (DN) of the issuer of the digital certificate, as well as the serial number of the digital certificate. However, since multiple digital certificate issuers may use the same DN, further identification information, in the form of a hash of the issuer's public key, is also included in the request. Therefore, target digital certificate information in an OCSP request includes a hash algorithm identifier, a hash of the DN of the digital certificate issuer generated using the hash algorithm, a hash of the issuer's public key, also generated using the hash algorithm, and the serial number of the target digital certificate.

The request may or may not be signed by a requestor. Further optional information may also be included in a request and processed by an OCSP responder.

When a messaging client is operating on a mobile device **22**, OCSP may be desirable in that it reduces the processing and memory resources necessary to check revocation status of a digital certificate relative to CRL-based revocation status checking. However, OCSP requests can be relatively long and thereby consume the typically limited wireless communication resources and power available on a mobile device. The proxy system **39**, in conjunction with an appropriately enabled mobile device **38**, is used to optimize OCSP and similar protocols involving remote systems for mobile devices, as described in further detail below.

FIG. **3** is a block diagram of a system implementing a digital certificate revocation status check system. The mobile device **38** includes a memory **52**, a messaging system **60**, a proxy system client module **62**, a user interface (UI) **64**, and a wireless transceiver **66**. The memory **52** preferably includes a storage area for a digital certificate store **54**, as well as possibly other data stores such as an address book **56** in which messaging contact information is stored, and an application data storage area **58** which stores data associated with software applications installed on the mobile device **38**. Data stores **56** and **58** are illustrative examples of stores that may be implemented in a memory **52** on mobile device **38**. The memory **52** may also be used by other device systems in addition to those shown in FIG. **3** to store other types of data.

The memory **52** is illustratively a writeable store such as a RAM into which other device components may write data. The digital certificate store **54** is a storage area dedicated to storage of digital certificates on the mobile device **38**. Digital certificates may be stored in the digital certificate store **54** in the format in which they are received, or may alternatively be parsed or otherwise translated into a storage format before being written to the store **54**.

The messaging system **60** is connected to the wireless transceiver **66** and is thus enabled for communications via the wireless network **36**. The messaging system **60**, in most implementations, is a messaging client embodied in a software application.

The proxy system client module **62**, which is also preferably implemented as a software application or component, is coupled to the messaging system **60**, the wireless transceiver **66**, the digital certificate store **54**, and the UI **64**. Revocation status for any of the digital certificates stored in the digital certificate store **54**, as well as digital. certificates received by the messaging system **60** but not yet stored in the digital certificate store **54**, may be checked using the proxy system client module **62**, as described in detail below.

The UI **64** may include such UI components as a keyboard or keypad, a display, or other components which accept inputs from or provide outputs to a user of the mobile device **38**. Although shown as a single block in FIG. **3**, a mobile device typically includes more than one UI, and the UI **64** therefore represents one or more user interfaces.

The wireless network **36**, wireless gateway **34**, WAN **32** and revocation status information provider **37** are the same as similarly-labelled components in FIG. **2**.

The proxy system **39** includes a proxy system service module **68** and a status provider client module **70**. The proxy system **39** illustratively comprises one or more computers connected to the WAN **32** and operable to receive an encryption item status request from mobile device **38**, or some other client system, and perform the status request and attendant processing steps on behalf of the mobile device **38**. In one embodiment, the proxy system **39** is an intermediate computer that performs the status request on behalf of the mobile device **38**. The intermediate computer may be further operable to provide the address of the mobile device with the status request. In another embodiment, the proxy system **39** comprises a proxy server that is also operable to perform proxy server functions, such as providing security, administrative control, and caching, in addition to performing the status request on behalf of the mobile device **38**.

The proxy system service module **68** is configured to exchange information with the proxy system client module **62**, and the status provider client module **70** is adapted to exchange information with the revocation status provider **37**. Each of these components, the status provider client module **70** and the proxy system service module **68** is preferably a software application or module operating at the proxy system **39**. These software applications may be embodied in a single computer program, or may alternatively be separate programs executed independently.

In operation, the messaging system **60** on the mobile device **38** receives and possibly sends secure messages via the wireless network **36** as described above. When a signature on a received secure message is to be verified or a message is to be sent with an encrypted session key, the messaging system **60** may retrieve a public key for an entity (i.e., a sender of a received message or a recipient of a message to be sent) from a digital certificate. Before the public key is used, however,

the messaging system **60** or a user thereof may wish to check that the digital certificate containing the public key is valid and has not been revoked.

Digital certificate verification operations may be performed automatically, when a digital certificate is received with a secure message, or at predetermined or user-configurable intervals, for example, or when invoked by a user through a UI **64**.

Different types of digital certificate checking operations may also be dependent upon different controls. For example, the validity and revocation status of a digital certificate may be checked automatically when the digital certificate is first loaded onto the mobile device **38**. If the digital certificate is valid and not revoked, then it may be assumed to be valid until an expiry time or during a validity period specified in the digital certificate, whereas its revocation status may thereafter be checked once every week to ensure that it is not revoked before it expires.

As described above, digital certificate status information requests to a remote information provider such as **37** may be relatively long and are therefore not optimal for implementation in a mobile device **38** or other bandwidth-limited communication systems. The proxy system client and service modules **62** and **68** are adapted to reduce the amount of information that is sent from the mobile device **38** to request status information for a digital certificate.

When a user of the mobile device **38** wishes to check the revocation status of a digital certificate, the proxy system client module **62**, or possibly a software application which operates in conjunction with the proxy system client module **62**, is invoked by entering an appropriate command on a UI **64**, such as a keyboard, for example. The user also specifies the particular digital certificate to be checked, for instance using the serial number or subject name of the digital certificate. Alternatively, the proxy system client module **62** accesses the digital certificate store **54** to display to the user a list of currently stored digital certificates, from which the user selects one or more digital certificates to be checked.

The proxy system client module **62** then preferably either extracts from the selected digital certificate(s) or-obtains from the user through a UI **64** any information required by the proxy system service module **68** for a digital certificate revocation status check. Since the proxy system **39** provides an interface between the mobile device **38** and the status information provider **37**, requests and responses between the proxy system client module **62** and proxy system service module **68** need not conform to the protocol used between the status provider client module **70** and the status information provider **37**. Therefore, although the status provider **37** and status provider client module **70** may support OCSP or a similar protocol, the proxy system service module **68** and proxy system client module **62** preferably support a more wireless-friendly protocol involving less data exchange, such as smaller requests.

The particular information extracted or obtained by the proxy system client module **62** is dependent upon the communication protocol implemented between the proxy system client module **62** and the proxy system service module **68**. The proxy system client module **62** preferably extracts a digital certificate subject name, serial number, issuer name, and other digital certificate information from a digital certificate stored in the digital certificate store **54**. If digital certificates are first parsed so that parsed data is stored in the digital certificate store **54**, then such information is extracted from the parsed data in the digital certificate store **54** by the proxy system client module **62**. If further information is required, a user is prompted to enter the information.

When all required information has been extracted or otherwise obtained by the proxy system client module **62**, a request is formatted and sent to the proxy system service module **68**. The content of this request is also dependent upon the communication protocol used between the proxy system service module **68** and client module **62**. If more than one type of service is supported, then the request may specify which type of service is requested. In some implementations, only a single service may be supported, such that no service type need be specified.

Information received by the proxy system service module **68** is preferably passed to the status provider client module **70**. This information is then used by the status provider client module **70** to format a request for the status information provider **37**. If the revocation status information provider **37** and status provider client module **70** support OCSP, for example, information provided by the proxy system service module **68**, as well as any further required information, are formatted into an OCSP request. In some cases, the information provided by the proxy system service module **68** includes all required information, whereas in other cases, further information is extracted from other sources. For example, where the proxy system **39** is configured to store a mapping table or like element which maintains a correspondence between digital certificate issuers and serial numbers and/or subject names, then the status provider client module **70** may format a status request for the correct revocation status information provider **37** based on only a serial number or subject name received by the proxy system service module **68** from the proxy system client module **62**.

In FIG. **3**, it is assumed that the revocation status information provider **37** supports an ORS or like service. Upon receiving a request, the revocation status information provider **37**, which is an OCSP responder when the provider **37** and the client module **70** support OCSP, checks the request to ensure that it is formatted properly, that the requested service is a service that it is configured to provide, and that the request includes all of the information required for the requested service. If these conditions are not met, then the provider **37** returns an error message to the client module **70**. The client module **70** then performs error processing to provide any missing required information and possibly to request missing information from the mobile device **38** through the proxy system service module **68**, or returns an error message to the proxy system service module **68**, which then formats and sends an error message to the proxy system client module **62** as a response to its initial service request. Other conditions, such as when a provider **37** receives an unsigned request but is configured to expect signed requests, or when a provider service is unable to respond, may also result in an error message being returned to the provider client module **70**.

If the request meets required conditions, then a definitive response is returned to the provider client module **70**. A definitive response may include one of a plurality of status indications, such as a "valid" or like indication when a target digital certificate has not been revoked, a "revoked" indication when the target digital certificate has been revoked, or an "unknown" indication if the status provider **37** has no record or knowledge of the target digital certificate.

Furthermore, the proxy system client module **62** may also be operable to classify the digital certificate as "pending" when awaiting the status of the digital certificate after sending a request. The status of the digital certificate is then changed from pending to one of valid, revoked, or unknown after the proxy system client module **62** receives the corresponding status indication from the proxy system **39**. The proxy system client module **62** may also be configured to prompt a user via

an I/O device on the mobile device **38** to confirm an action to be executed on a data item if the data item includes a digital signature with a status of pending, revoked, or unknown.

A response returned to the status provider client module **70** by the status information provider **37** is passed to the proxy system service module **68**, which prepares and sends a response to the proxy system client module **62**. When the response from the provider **37** is signed and the proxy system client module **62** or another component on the mobile device **38** is configured to verify status response signatures, then the entire response from the status provider **37**, or possibly the signed portions thereof, are preferably forwarded to the proxy system client module **62** substantially unchanged. However, if the proxy system service module **68** or the status provider client module **70** checks status response signatures on behalf of the mobile device **38**, then only certain parts of the response, for example, the status indication and the digital certificate serial number or subject name, are preferably extracted by the proxy system service module **68** and formatted into a response that is then sent to the proxy system client module **62**. The response from the proxy system service module **68** is then processed by the proxy system client module **62** to determine whether the digital certificate has been revoked.

The presence of a proxy system client module **62** preferably does not preclude digital certificate validity and revocation status checks according to known techniques. Thus, digital certificate status checks involving remote systems such as the status information provider **37** are complementary to other status check operations for which the mobile device **38** are enabled.

While the embodiment of FIG. **3** depicts the wireless gateway **34**, the proxy system **39**, and the revocation status provider **37** as separate systems communication over the WAN **32**, these systems may be combined. For example, in an alternative embodiment, a software application comprising the proxy system service module **68** and the status provider client module **70** is stored and executed on the wireless gateway **34**.

In yet another embodiment, the software application comprising the proxy system service module **68** and the status provider client module **70** is stored and executed on the revocation status provider **37**. In still another embodiment, the software application comprising the proxy system service module **68** and the status provider client module **70** is stored and executed on the message server **26** (FIG. **1**). Of course, other configurations and communication paths for computer systems distributed throughout one or more networks that enable the functionality of the client/proxy digital certificate status system as disclosed herein may also be used.

In another alternative embodiment, the wireless gateway **34** is operable to determine if a data item, such as an S/MIME message to be transmitted to the mobile device **38**, is signed with a digital signature or includes a digital certificate. If so, then the wireless gateway **34** pre-emptively queries the revocation status provider **37** to obtain the digital certificate status for the signer of the S/MIME message.

The digital certificate status is preferably obtained before the S/MIME message is transmitted to the mobile device **38**, in which case the S/MIME message is stored at the wireless gateway **34**. The wireless gateway **34** may be further operable to discard the S/MIME message if the digital certificate is not valid or expired, or alternatively may transmit the S/MIME message to the mobile device **38** with a notification that the digital certificate status is not valid or is expired.

FIG. **4**A provides a flow diagram illustrating a method of checking digital certificate revocation status. At step **80**, any digital certificates for which a status check is to be performed are identified. As described above, this step could be performed automatically or the digital certificates could be selected by a user. A service request is then prepared and sent to the proxy system at step **82**. At step **84**, the proxy system prepares and sends a service request to a status information provider such as an OCSP responder. The status information provider then checks the request to ensure that it is formatted properly, that the requested service, digital certificate revocation status in this example, is supported by the provider, and that all required information is included in the request. These checks are performed at step **86**.

If the request does not satisfy these conditions, then an error message is returned to the proxy system at step **88**. An error message is also returned to the mobile device at step **92**. Alternatively, error processing may be executed at step **90**, to obtain further information when the request does not include all required information, for example, after which a new service request may be prepared and sent to the provider at step **84**.

When the request satisfies the conditions in step **86**, the status information provider returns a status indication to the proxy system at step **94**, in response to the service request from the proxy system. Then, at step **96**, the proxy system returns the entire response from the status information provider, or at least parts thereof, to the mobile device, as a response to the initial service request from the mobile device.

Although the system and method described above relate to the illustrative example of digital certificate revocation status checking, digital certificate validity checks, according to the DPV and DPD services of OCSP or other protocols, for example, may similarly be optimized for mobile devices and other types of processing-, memory- or communication resource-constrained systems through. a proxy system client module and service. A proxy system **39** may also be enabled to provide its proxy service to multiple mobile devices.

FIG. **4**B provides a flow diagram illustrating another method of checking digital certificate revocation status. In this method, the wireless gateway **34** (FIG. **3**) executes a proxy program as previously described, and is further operable to determine if a data item, such as an S/MIME message, to be transmitted to the mobile device **38** includes a digital certificate. If so, the wireless gateway **34** preemptively queries the revocation status information provider **37**.

At step **200**, the wireless gateway **34** receives a data item to be transmitted to the mobile device **38**. In step **202**, the wireless gateway determines if the data item includes a digital certificate. If the data item does not include a digital certificate, then the data item is sent to the mobile device **38**, as shown in step **216**.

However, if the data item includes a digital certificate, then the wireless gateway **34** stores the data item and prepares a service request that is sent to a status provider, as shown in step **204**.

The status information is received in step **206**, and in step **208** the **20** wireless gateway **34** determines if the digital certificate status is valid, revoked, or unknown. If the digital certificate is valid, then the wireless gateway **34** attaches a valid indicator to the data item, and the data item is then redirected to the mobile device **38**, as shown in steps **210** and **216**. If the digital certificate is revoked, then the wireless gateway **34** attaches a revoked indicator to the data item, and the data item is then sent to the mobile device **38**, as shown in steps **212** and **216**. If the digital certificate is unknown, then the wireless gateway **34** attaches an unknown indicator to the data item, and the data item is sent to the mobile device **38**, at steps **214** and **216**.

Thus, upon receipt of a data item that includes a digital certificate, the mobile device determines the status of the digital certificate immediately by consulting the valid, revoked or unknown indicator that is attached to the data item.

In an alternative embodiment, the wireless gateway **34** preemptively queries the revocation status information provider, but forwards the received data item to the mobile device with an indicator, a "pending" indicator for example, which indicates that digital certificate status has been queried. A further indication of certificate status is then sent to the mobile device when a status indication is received from the status information provider.

In another embodiment, the message server **26** (FIG. **1**) also comprises a redirection system as described above. The redirection system executes a proxy program and is further operable to determine if a data item to be transmitted to the mobile device **38** includes a digital certificate. If so, the redirection system preemptively queries the revocation status provider **37** to obtain the digital certificate status, and performs similar processing steps as described with respect to the wireless gateway **34** and FIG. **4**B.

In a further embodiment, a mobile device and a proxy system include multiple client and service modules. FIG. **5** is a block diagram of a system implementing a digital certificate revocation status check system having multiple proxy system client modules. In FIG. **5**, the memory **102**, the data stores **104**, **106**, **108**, the messaging system **110**, the UI **114**, the wireless transceiver **116**, the wireless network **118**, the wireless gateway **120**, and the WAN **122** are substantially the same as similarly labelled components in FIG. **3**.

The mobile device **100** includes client modules **112**, including proxy system client module A **111** and proxy system client module N **113**, and possibly other proxy system client modules. The proxy system **128** includes corresponding proxy system service modules A and N, **132** and **136**. The proxy system **128** also includes status provider client modules A and N, **130** and **134**, which are configured for communications with the status information provider A **124** and the status information provider N **126**, respectively.

The system shown in FIG. **5** operates substantially as described above. When the status of one or more digital certificates, such as revocation status, for example, is to be checked, each proxy system client module **111** and **113** preferably extracts or otherwise obtains information required in a service request to its respective proxy system service module **132** and **136**. The status provider client modules **130** and **134** then use the information from the service request from the mobile device **38**, and possibly information available at the proxy system **128**, to prepare a service request to status information providers **124** and **126**. Responses returned by the status information providers **124** and **126**, or at least portions thereof, are then reformatted if necessary and returned to the proxy system client modules **111** and **113** at the mobile device **100**.

Each proxy system client module **111** and **113** may be adapted to collect request information and process response information for a different remote digital certificate status check protocol. However, the information collected by both proxy system client modules **111** and **113** may be combined into a single service request to the proxy system **128**. Each proxy system service module **132** and **136** then extracts information from the service request required for a service request to its associated status information provider **124** and **126**. Responses returned to the status provider client modules **130** and **134** by the status provider systems **124** and **26** is returned to the proxy system client modules **111** and **113** either separately or in a single response. For example, when one or both of the status information providers **124** and **126** signs its responses, and the proxy system client modules **132** and **136** are configured to verify response signatures, then separate responses are preferably returned to the proxy system client modules **111** and **113** according to their respective protocols. If responses are not signed, however, the responses may be combined into a single response.

A multiple-client module system as shown in FIG. **5** is particularly useful when a user wishes to check the validity and/or revocation status of an entire digital certificate chain which includes digital certificates for which status information is available from different status information providers. In known systems, separate requests for each digital certificate in the chain must be sent to the status information providers. In the system of FIG. **5**, however, only a single request need be sent from the mobile device **100** to obtain status information from a number of status information providers. Furthermore, common information that is required by all proxy system client modules and service modules need be included only once in an initial service request sent to the proxy system **128**, thereby reducing redundancy in the initial service request.

FIG. **6** is a block diagram of a wireless mobile communication device. The mobile device **600** is preferably a two-way communication device having at least voice and data communication capabilities. The mobile device **600** preferably has the capability to communicate with other computer systems on the Internet. Depending on the functionality provided by the mobile device, the mobile device may be referred to as a data messaging device, a two-way pager, a mobile telephone with data messaging capabilities, a wireless Internet appliance, or a data communication device (with or without telephony capabilities). As mentioned above, such devices are referred to generally herein simply as mobile devices.

The mobile device **600** includes a transceiver **611**, a microprocessor **638**, a display **622**, a Flash memory **624**, a random access memory (RAM) **626**, auxiliary input/output (I/O) devices **628**, a serial port **630**, a keyboard **632**, a speaker **634**, a microphone **636**, a short-range wireless communications sub-system **640**, and other device sub-systems **642**. The transceiver **611** includes transmit and receive antennas **616**, **618**, a receiver (Rx) **612**, a transmitter (Tx) **614**, one or more local oscillators (LOs) **613**, and a digital signal processor (DSP) **620**. Within the Flash memory **624**, the mobile device **600** includes a plurality of software modules **624**A-**624**N that can be executed by the microprocessor **638** (and/or the DSP **620**), including a voice communication module **624**A, a data communication module **624**B, and a plurality of other operational modules **624**N for carrying out a plurality of other functions.

The mobile device **600** is preferably a two-way communication device having voice and data communication capabilities. Thus, for example, the mobile device **600** may communicate over a voice network, such as any of the analog or digital cellular networks, and may also communicate over a data network. The voice and data networks are depicted in FIG. **6** by the communication tower **619**. These voice and data networks may be separate communication networks using separate infrastructure, such as base stations, network controllers, etc., or they may be integrated into a single wireless network. References to the network **619** should therefore be interpreted as encompassing both a single voice and data network and separate networks.

The communication subsystem **611** is used to communicate with the network **619**. The DSP **620** is used to send and receive communication signals to and from the transmitter **614** and receiver **612**, and may also exchange control information with the transmitter **614** and receiver **612**. If the voice

and data communications occur at a single frequency, or closely-spaced set of frequencies, then a single LO **613** may be used in conjunction with the transmitter **614** and receiver **612**. Alternatively, if different frequencies are utilized for voice communications versus data communications, then a plurality of LOs **613** can be used to generate a plurality of frequencies corresponding to the network **619**. Although two antennas **616**, **618** are depicted in FIG. **6**, the mobile device **600** could be used with a single antenna structure. Information, which includes both voice and data information, is communicated to and from the communication module **611** via a link between the DSP **620** and the microprocessor **638**.

The detailed design of the communication subsystem **611**, such as frequency band, component selection, power level, etc., will be dependent upon the communication network **619** in which the mobile device **600** is intended to operate. For example, a mobile device **600** intended to operate in a North American market may include a communication subsystem **611** designed to operate with the Mobitex or DataTAC mobile data communication networks and also designed to operated with any of a variety of voice communication networks, such as AMPS, TDMA, CDMA, PCS, etc., whereas a mobile device **600** intended for use in Europe may be configured to operate with the GPRS data communication network and the GSM voice communication network. Other types of data and voice networks, both separate and integrated, may also be utilized with the mobile device **600**.

Depending upon the type of network **619**, the access requirements for the mobile device **600** may also vary. For example, in the Mobitex and DataTAC data networks, mobile devices are registered on the network using a unique identification number associated with each device. In GPRS data networks, however, network access is associated with a subscriber or user of the mobile device **600**. A GPRS device typically requires a subscriber identity module ("SIM"), which is required in order to operate the mobile device **600** on a GPRS network. Local or non-network communication functions (if any) may be operable, without the SIM, but the mobile device **600** will be unable to carry out any functions involving communications over the network **619**, other than any legally required operations, such as '911' emergency calling.

After any required network registration or activation procedures have been completed, the mobile device **600** may send and receive communication signals, preferably including both voice and data signals, over the network **619**. Signals received by the antenna **616** from the communication network **619** are routed to the receiver **612**, which provides for such operations as signal amplification, frequency down conversion, filtering, channel selection, and analog to digital conversion. Analog to digital conversion of the received signal allows more complex communication functions, such as digital demodulation and decoding to be performed using the DSP **620**. In a similar manner, signals to be transmitted to the network **619** are processed, including modulation and encoding, for example, by the DSP **620** and are then provided to the transmitter **614** for digital to analog conversion, frequency up conversion, filtering, amplification and transmission to the communication network **619** via the antenna **618**. Although a single transceiver **611** is shown in FIG. **6** for both voice and data communications, it is possible that the mobile device **600** may include two distinct transceivers, a first transceiver for transmitting and receiving voice signals, and a second transceiver for transmitting and receiving data signals. Multiple transceiver may also be provided in a mobile device adapted to operate within more than one communication network or multiple frequency bands.

In addition to processing the communication signals, the DSP **620** also provides for receiver and transmitter control. For example, the gain levels applied to communication signals in the receiver **612** and transmitter **614** may be adaptively controlled through automatic gain control algorithms implemented in the DSP **620**. Other transceiver control algorithms could also be implemented in the DSP **620** in order to provide more sophisticated control of the transceiver **611**.

The microprocessor **638** preferably manages and controls the overall operation of the mobile device **600**; Many types of microprocessors or microcontrollers could be used here, or, alternatively, a single DSP **620** could be used to carry out the functions of the microprocessor **638**. Low-level communication functions, including at least data and voice communications, are performed through the DSP **620** in the transceiver **611**. Other, high-level communication applications, such as a voice communication application **624**A, and a data communication application **624**B are stored in the Flash memory **624** for execution by the microprocessor **638**. For example, the voice communication module **624**A may provide a high-level user interface operable to transmit and receive voice calls between the mobile device **600** and a plurality of other voice devices via the network **619**. Similarly, the data communication module **624**B may provide a high-level user interface operable for sending and receiving data, such as e-mail messages, files, organizer information, short text messages, etc., between the mobile device **600** and a plurality of other data devices via the network **619**. On the mobile device **600**, a secure messaging software application, incorporating software modules corresponding to the messaging system **60** and the proxy system client module **62** or client modules **113** and **111**, for example, may operate in conjunction with the data communication module **624**B in order to implement the techniques described above.

The microprocessor **638** also interacts with other device subsystems, such as the display **622**, the Flash memory **624**, the RAM **626**, the auxiliary input/output (I/O) subsystems **628**, the serial port **630**, the keyboard **632**, the speaker **634**, the microphone **636**, the short-range communications subsystem **640**, and any of the other device subsystems generally designated as **642**. For example, the modules **624**A-N are executed by the microprocessor **638** and may provide a high-level interface between a user and the mobile device **600**. This interface typically includes a graphical component provided through the display **622**, and an input/output component provided through the auxiliary VO **628**, the keyboard **632**, the speaker **634**, or the microphone **636**. Such interfaces are designated generally as UI **64** in FIGS. **3** and **5**.

Some of the subsystems- shown in FIG. **6** perform communication-related functions, whereas other subsystems may provide "resident" or on-device functions. Notably, some subsystems, such as the keyboard **632** and the display **622** are used for both communication-related functions, such as entering a text message for transmission over a data communication network, and device-resident functions such as a calculator or task list or other PDA type functions.

Operating system software used by the microprocessor **638** is preferably stored in a non-volatile store such as Flash memory **624**. In addition to the operating system and communication modules **624**A-N, the Flash memory **624** may also include a file system for storing data. A storage area is also preferably provided in the Flash memory **624** to store digital certificates, address book entries and possibly other information required for messaging, shown as data stores **54**, **56** and **58** in FIGS. **3** and **5**. The operating system, specific device applications or modules, or parts thereof, may be temporarily loaded into a volatile store, such as RAM **626** for

faster operation. Moreover, received communication signals may also be temporarily stored to RAM **626**, before permanently writing them to a file system located in the Flash memory **624**.

An exemplary application module **624**N that may be loaded onto the mobile device **600** is a personal information manager (PIM) application providing PDA functionality, such as calendar events, appointments, and task items. This module **624**N may also interact with the voice communication module **624**A for managing phone calls, voice mails, etc., and may also interact with the data communication module **624**B for managing e-mail communications and other data transmissions. Alternatively, all of the functionality of the voice communication module **624**A and the data communication module **624**B may be integrated into the PIM module.

The Flash memory **624** preferably provides a file system to facilitate storage of PIM data items on the device. The PIM application preferably includes the ability to send and receive data items, either by itself, or in conjunction with the voice and data communication modules **624**A, **624**B, via the wireless network **619**. The PIM data items are preferably seamlessly integrated, synchronized and updated, via the wireless network **619**, with a corresponding set of data items stored or associated with a host computer system, thereby creating a mirrored system for data items associated with a particular user.

Although shown as a Flash memory **624**, those skilled in the art will appreciate that other types of non-volatile store, such as a battery backed-up RAM, for example, could be used in addition to or instead of the Flash memory **624**.

The mobile device **600** may also be manually synchronized with a computer system by placing the mobile device **600** in an interface cradle, which couples the serial port **630** of the mobile device **600** to the serial port of the computer system. The serial port **630** may also be used to enable a user to set preferences through an external device or software application, to download other application modules **624**N for installation, and possibly to load digital certificates onto a mobile device. This wired download path may further be used to load an encryption key onto the device, which is a more secure method than exchanging encryption information via the wireless network **619**.

Additional application modules **624**N may be loaded onto the mobile device **600** through the network **619**, through an auxiliary I/O subsystem **628**, through the serial port **630**, through the short-range communications subsystem **640**, or through any other suitable subsystem **642**, and installed by a user in the Flash memory **624** or RAM **626**. Such flexibility in application installation increases the functionality of the mobile device **600** and may provide enhanced on-device functions, communication-related functions, or both. For example, secure communication applications may enable electronic commerce functions and other such financial transactions to be performed using the mobile device **600**.

When the mobile device **600** is operating in a data communication mode, a received signal, such as a text message or a web page download, is processed by the transceiver **611** and provided to the microprocessor **638**, which preferably further processes the received signal for output to the display **622**, or, alternatively, to an auxiliary I/O device **628**. A digital certificate received by the transceiver **611**, in response to a request to a PKS or attached to a secure message, for example, may be added to a digital certificate store in the Flash memory **624** if it has not already been stored. Validity and/or revocation status of such a digital certificate may also be checked as described above. A user of mobile device **600** may also compose data items, such as e-mail messages, using the keyboard **632**, which is preferably a complete alphanumeric keyboard laid out in the QWERTY style, although other styles of complete alphanumeric keyboards such as the known DVORAK style may also be used. User input to the mobile device **600** is further enhanced with a plurality of auxiliary I/O devices **628**, which may include a thumbwheel input device, a touchpad, a variety of switches, a rocker input switch, etc. The composed data items input by the user may then be transmitted over the communication network **619** via the transceiver **611**.

When the mobile device **600** is operating in a voice communication mode, the overall operation of the mobile device **600** is substantially similar to the data mode, except that received signals are preferably output to the speaker **634** and voice signals for transmission are generated by a microphone **636**. In addition, the secure messaging techniques described above might not necessarily be applied to voice communications. Alternative voice or audio I/O subsystems, such as a voice message recording subsystem, may also be implemented on the mobile device **600**. Although voice or audio signal output is preferably accomplished primarily through the speaker **634**, the display **622** may also be used to provide an indication of the identity of a calling party, the duration of a voice call, or other voice call related information. For example, the microprocessor **638**, in conjunction with the voice communication module **624**A and the operating system software, may detect the caller identification information of an incoming voice call and display it on the display **622**.

The short-range communications subsystem **640** may include an infrared device and associated circuits and components, or a short-range wireless communication module such as a Bluetooth™ module or an 802.11 module to provide for communication with similarly-enabled systems and devices. Those skilled in the art will appreciate that "Bluetooth" and "802.11" refer to sets of specifications, available from the Institute of Electrical and Electronics Engineers, relating to wireless personal area networks and wireless LANs, respectively.

The above description relates to preferred embodiments by way of example only. Other embodiments may be realized. For example, although digital certificate status checks are described primarily in the context of a wireless mobile communication device, the systems and methods disclosed herein are also applicable to messaging clients operating on other platforms, including those operating on desktop and laptop computer systems, networked computer workstations and other types of messaging clients for which digital certificate checks involving remote systems may be desired.

While the above description also relates primarily to OCSP, other protocols may similarly be optimized through an intermediate proxy system which operates in conjunction with both remote systems and proxy system client modules. Such other protocols are not limited to digital certificate status check protocols. A proxy system and proxy system client modules may be configured to provide other services than digital certificate status check services.

FIG. **7** provides a functional block diagram **500** illustrating the processing of a digital certificate status request. Although the processing of a digital certificate status request is shown in FIG. **7**, other types of status request may also be handled as depicted in FIG. **7**. A client system has a status information requirement **502** to be served by an external system, such as a proxy system running a proxy system program **504** embodying one or more proxy system service modules and status provider client modules.

The digital certificate status request is sent to the proxy system program **504** running on a proxy system. The digital certificate status request sent to the proxy system program

504 conforms to a client/proxy protocol. The proxy system program **504** is operable to receive the digital certificate status request and perform the status request and attendant processing steps on behalf of the client system, as described with reference to the proxy system service module **68** and the status provider client module **70**. The client/proxy protocol may conform to a known communication protocol, or may instead be a proprietary protocol.

The proxy system program **504** then prepares the digital certificate status request, including information in the request from the client system and possibly information available at the proxy system, in the map table **514**, for example, to be sent according to a status query protocol to a status provider system running a status provider program **506**. The status query protocol may conform to a known status protocol, such as OCSP, or may instead be a proprietary protocol. In one embodiment, the client/proxy protocol is a first protocol, such as a proprietary protocol, and the status query protocol is a second protocol, such as OCSP.

The status provider program **506** then processes the query and the status provider system provides digital certificate status data to the proxy system program **504**. The digital certificate status data illustratively comprises a digital certificate status indicator. If the digital certificate comprises a chain of digital certificates, then a corresponding number of digital certificate status indicators are provided to the proxy system program **504**. Furthermore, the status provider program **506** may require additional information from the proxy system program **504**, and thus, multiple communications between the proxy system program **504** and the status provider program **506** may occur. Accordingly, multiple communications **508** and **510** are represented between the proxy system program **504** and the status provider program **506**.

Upon completion of the digital certificate status request, the proxy system program **504** prepares the digital certificate status data for transmission back to the client system. In one embodiment, the proxy system program **504** selects the entire set of status reply data received from the status provider program **506** to be transmitted to the client system. In another embodiment, the proxy system program selects only a single status indicator, such as valid, invalid, unknown, or revoked to be transmitted to the client system. For example, if one digital certificate in a chain of digital certificates is found to be invalid by the status provider program **506**, then the proxy system program **504** may select only an invalid status indicator to be transmitted to the client system. Alternatively, the proxy system program **504** may select an invalid status indicator to be transmitted to the client system and also data to specify which digital certificate in a digital certificate chain is invalid. Other data combinations may also be derived to be sent back to the client system.

The client system and the proxy system store corresponding mapping tables **512** and **514** or like elements which maintain a correspondence between digital certificate issuers and serial numbers and/or subject names. The client system may then provide only a unique indicator for a corresponding digital certificate, such as a serial number or subject name. The proxy system program **504** may then format a digital certificate status request according to the status query protocol for the status provider system running the status provider program **506** based on only a serial number or subject name received from the client system. Similarly, a unique identifier returned to the client system by the proxy system is resolved if necessary by the client system using the mapping table **512**. Thus, if the client system comprises a mobile device operable to communicate with the proxy system over a wireless network, the mapping tables **512** and **514** conserve the relatively limited bandwidth of the RF network.

Still further examples of the wide scope of the systems and methods disclosed herein are illustrated in FIGS. **8-10**. FIGS. **8-10** describe additional uses of the systems and methods within different exemplary communication systems.

FIG. **8** is a block diagram showing a communication system. In FIG. **8**, there is shown a computer system **802**, a WAN **804**, corporate LAN **806** behind a security firewall **808**, wireless infrastructure **810**, wireless networks **812** and **814**, and mobile devices **816** and **818**. The corporate LAN **806** includes a message server **820**, a wireless connector system **828**, a data store **817** including at least a plurality of mailboxes **819**, a desktop computer system **822** having a communication link directly to a mobile device such as through physical connection **824** to an interface or connector **826**, and a wireless VPN router **832**. Operation of the system in FIG. **8** is described below with reference to the messages **833**, **834** and **836**.

The computer system **802** is, for example, a laptop, desktop or palmtop computer system configured for connection to the WAN **804**. Such a computer system may connect to the WAN **804** via an ISP or ASP. Alternatively, the computer system **802** may be a network-connected computer system that, like the computer system **822** for example, accesses the WAN **804** through a LAN or other network. Many modem mobile devices are enabled for connection to a WAN through various infrastructure and gateway arrangements, so that the computer system **802** may also be a mobile device.

The corporate LAN **806** is an illustrative example of a central, server-based messaging system that has been enabled for wireless communications. The corporate LAN **806** may be referred to as a "host system", in that it hosts both a data store **817** with mailboxes **819** for messages, as well as possibly further data stores (not shown) for other data items, that may be sent to or received from mobile devices **816** and **818**, and the wireless connector system **828**, the wireless VPN router **832**, or possibly other components enabling communications between the corporate LAN **806** and one or more mobile devices **816** and **818**. In more general terms, a host system is one or more computers at, with, or in association with which a wireless connector system is operating. The corporate LAN **806** is one preferred embodiment of a host system, in which the host system is a server computer running within a corporate network environment operating behind and protected by at least one security communications firewall **808**. Other possible central host systems include ISP, ASP and other service provider or mail systems. Although the desktop computer system **824** and interface/connector **826** may be located outside such host systems, wireless communication operations may be similar to those described below.

The corporate LAN **806** implements the wireless connector system **828** as an associated wireless communications enabling component, which will normally be a software program, a software-application, or a software component built to work with at least one message server **820**. The wireless connector system **828** is used to send user-selected information to and to receive information from, one or more mobile devices **816** and **818**, via one or more wireless networks **812** and **814**. The wireless connector system **828** may be a separate component of a messaging system, as shown in FIG. **8**, or may instead be partially or entirely incorporated into other communication system components. For example, the message server **820** may incorporate a software program, application, or component implementing the wireless connector system **828**, portions thereof, or some or all of its functionality.

The message server **820**, running on a computer behind the firewall **808**, acts as the main interface for the corporation to exchange messages, including for example electronic mail, calendaring data, voice mail, electronic documents, and Other PIM data with a WAN **804**, such as the Internet. The particular intermediate operations and computers are dependent upon the specific type of message delivery mechanisms and networks via which messages are exchanged, and therefore have not been shown in FIG. **8**. The functionality of the message server **820** may extend beyond message sending and receiving, providing such features as dynamic database storage for data like calendars, to-do lists, task lists, e-mail, and documentation, as described above.

Message servers such as **820** normally maintain a plurality of mailboxes **819** in one or more data stores such as **817** for each user having an account on the server. The data store **817** includes mailboxes **819** for a number ("n") of user accounts. Messages received by the message server **820** that identify a user, a user account, a mailbox, or possibly another address associated with a user, account or mailbox **819**, as a message recipient is typically stored in the corresponding mailbox **819**. If a message is addressed to multiple recipients or a distribution list, then copies of the same message may be stored to more than one mailbox **819**. Alternatively, the message server **820** may store a single copy of such a message in a data store accessible to all of the users having an account on the message server **820**, and store a pointer or other identifier in each recipient's mailbox **819**. In typical messaging systems, each user then accesses his or her mailbox **819** and its contents using a messaging client such as Microsoft Outlook or Lotus Notes, which normally operates on a PC, such as the desktop computer system **822**, connected in the LAN **806**. Although only one desktop computer system **822** is shown in FIG. **8**, those skilled in the art will appreciate that a LAN typically contains many desktop, notebook, and laptop computer systems. Each messaging client normally accesses a mailbox **819** through the message server **820**, although in some systems, a messaging client may enable direct access to the data store **817** and a mailbox **819** stored thereon by the desktop computer system **822**. Messages may also be downloaded from the data store **817** to a local data store on the desktop computer system **822**.

Within the corporate LAN **806**, the wireless connector system **828** operates in conjunction with the message server **820**. The wireless connector system **828** may reside on the same computer system as the message server **820**, or may instead be implemented on a different computer system. Software implementing the wireless connector system **828** may also be partially or entirely integrated with the message server **820**. The wireless connector system **828** and the message server **820** are preferably designed to cooperate and interact to allow the pushing of information to the mobile devices **816**, **818**. In such an installation, the wireless connector system **828** is preferably configured to send information that is stored in one or more data stores associated with the corporate LAN **806** to one or more of the mobile devices **816**, **818**, through the corporate firewall **808** and via the WAN **804** and one of the wireless networks **812**, **814**. For example, a user that has an account and associated mailbox **819** in the data store **817** may also have a mobile device, such as **816**. As described above, messages received by the message server **820** that identify a user, account, or mailbox **819** are stored to a corresponding mailbox **819** by the message server **820**. If a user has a mobile device, such as **816**, messages received by the message server **820** and stored to the user's mailbox **819** are preferably detected by the wireless connector system **828** and sent to the user's mobile device **816**. This type of functionality represents a "push" message sending technique. The wireless connector system **828** may instead employ a "pull" technique, in which items stored in a mailbox **819** are sent to a mobile device **816** or **818** responsive to a request or access operation made using the mobile device, or some combination of both techniques.

The use of a wireless connector **828** thereby-enables a messaging system including a message server **820** to be extended so that each user's mobile device **816**, **818** has access to stored messages of the message server **820**. Although the systems and methods described herein are not restricted solely to a push-based technique, a more detailed description of push-based messaging may be found in the United States Patent and incorporated by reference above. This push technique uses a wireless friendly encoding, compression and encryption technique to deliver all information to a mobile device, thus effectively extending the company firewall **808** to include the mobile devices **816** and **818**.

As shown in FIG. **8**, there are several paths for exchanging information with a mobile device **816**, **818** from the corporate LAN **806**. One possible information transfer path is through the physical connection **824** such as a serial port, using an interface or connector **826**. This path is useful for example for bulk information updates often performed at initialization of a mobile device **816**, **818** or periodically when a user of a mobile device **816**, **818** is working at a computer system in the LAN **806**, such as the computer system **822**. For example, as described above, PIM data is commonly exchanged over a such a connection as a serial port connected to a cradle in or upon which a mobile device **816**, **818** may be placed. The physical connection **824** may also be used to transfer other information from a desktop computer system **822** to a mobile device **816**, **818**, including private security keys ("private keys") such as private encryption or digital signature keys associated with the desktop computer system **822**, or other relatively bulky information such as digital certificates and CRLs.

Private key exchange using the physical connection **824** and the connector or interface **826** allows a user's desktop computer system **822** and mobile device **816** or **818** to share at least one identity for accessing all encrypted and/or signed mail. The user's desktop computer system **822** and mobile device **816** or **818** can also thereby share private keys so that either the host system **822** or the mobile device **816** or **818** can process secure messages addressed to the user's mailbox or account on the message server **820**. The transfer of digital certificates and CRLs over such a physical connection is desirable in that they represent a large amount of the data that is required for S/MIME, PGP and other public key security methods. A user's own digital certificate, a chain of digital certificates used to verify the user's digital certificate, and a CRL, as well as digital certificates, digital certificate chains and CRLs for other users, may be loaded onto a mobile device **816**, **818** from the user's desktop computer system **822**. This loading of other user's digital certificates and CRLs onto a mobile device **816**, **818** allows a mobile device user to select other entities or users with whom they might be exchanging secure messages, and to pre-load the bulky information onto the mobile device through a physical connection instead of over the air, thus saving time and wireless bandwidth when a secure message is received from or to be sent to such other users, or when the status of a digital certificate is to be determined based on one or more CRLs. CRL-based status checks can also be avoided where the systems and methods described herein are employed.

In known "synchronization" type wireless messaging systems, a physical path has also been used to transfer messages from mailboxes **819** associated with a message server **820** to mobile devices **816** and **818**.

Another method for data exchange with the mobile devices **816** and **818** is over-the-air, through the wireless connector system. **828** and using the wireless networks **812** and **814**. As shown in FIG. **8**, this could involve a Wireless VPN router **832**, if available in the network **806**, or, alternatively, a traditional WAN connection to wireless infrastructure **810** that provides an interface to one or more wireless networks such as **814**. The Wireless VPN router **832** provides for creation of a VPN connection directly through a specific wireless network **812** to a wireless device **816**. Such a Wireless VPN router **832** may be used in conjunction with a static addressing scheme. For example, if the wireless network **812** is an IP-based wireless network, then IPV6 would provide enough IP addresses to dedicate an IP address to every mobile device **816** configured to operate within the network **812** and thus make it possible to push information to a mobile device **816** at any time. A primary advantage of using a wireless VPN router **832** is that it could be an off-the-shelf VPN component which would not require wireless infrastructure **810**. A VPN connection may use a TCP/IP or UDP/IP connection to deliver messages directly to and from a mobile device **816**.

If a wireless VPN router **832** is not available, then a link to a WAN **804**, normally the Internet, is a commonly used connection mechanism that may be employed by the wireless connector system **828**. To handle the addressing of the mobile device **816** and any other required interface functions, wireless infrastructure **810** is preferably used. The wireless infrastructure **810** may also determine a most likely wireless network for locating a given user and track users as they roam between countries or networks. In wireless networks such as **812** and **814**, messages are normally delivered to and from mobile devices via RF transmissions between base stations and the mobile devices.

A plurality of connections to wireless networks **812** and **814** may be provided, including, for example, ISDN, Frame Relay or T1 connections using the TCP/IP protocol used throughout the Internet. The wireless networks **812** and **814** could represent distinct, unique and unrelated networks, or they could represent the same network in different countries, and may be any of different types of networks, including but not limited to, data-centric wireless networks, voice-centric wireless networks, and dual-mode networks that can support both voice and data communications over the same or similar infrastructure, such as any of those described above.

In some implementations, more than one over-the-air information exchange mechanism may be provided in the corporate LAN **806**. In FIG. **8** for example, the mobile devices **816** and **818** associated with users having mailboxes **819** associated with user accounts on the message server **820** are configured to operate on different wireless networks **812** and **814**. If the wireless network **812** supports IPv6 addressing, then the wireless VPN router **832** may be used by the wireless connector system **828** to exchange data with any mobile device **816** operating within the wireless network **812**. The wireless network **814** may be a different type of wireless network, however, such as the Mobitex network, in which case information is instead exchanged with the mobile device **818** operating within the wireless network **814** via a connection to the WAN-**804** and the wireless infrastructure **810**.

Operation of the system in FIG. **8** will now be described using an example of an e-mail message **833** sent from the computer system **802** and addressed to at least one recipient having both an account and mailbox **819** or like data store associated with the message server **820** and a mobile device **816** or **818**. However, the e-mail message **833** is intended for illustrative purposes only. The exchange of other types of information between the corporate LAN **806** is preferably also enabled by the wireless connector system **828**.

The e-mail message **833**, sent from the computer system **802** via the WAN **804**, may be fully in the clear, or signed with a digital signature and/or encrypted, depending upon the particular messaging scheme used. For example, if the computer system **802** is enabled for secure messaging using S/MIME, then the e-mail message **833** may be signed, encrypted, or both.

E-mail messages such as **833** normally use traditional SMTP, RFC822 headers and MIME body parts to define the format of the e-mail message. These techniques are all well known to one in the art. The e-mail message **833** arrives at the message server **820**, which determines into which mailboxes **819** the e-mail message **833** should be stored. As described above, a message such as the e-mail message **833** may include a user name, a user account, a mailbox identifier, or other type of identifier that is mapped to a particular account or associated mailbox **819** by the message server **820**. For an e-mail message **833**, recipients are typically identified using e-mail addresses corresponding to a user account and thus a mailbox **819**.

The wireless connector system **828** sends or mirrors, via the wireless network **812** or **814**, certain user-selected data items or parts of data items from the corporate LAN **806** to the user's mobile device **816** or **818**, preferably upon detecting that one or more triggering events has occurred. A triggering event includes, but is not limited to, one or more of the following: screen saver activation at a user's networked computer system **822**, disconnection of the user's mobile device **816** or **818** from the interface **826**, or receipt of a command sent from a mobile device **816** or **818** to the host system to start sending one or more messages stored at the host system. Thus, the wireless connector system **828** may detect triggering events associated with the message server **820**, such as receipt of a command, or with one or more networked computer systems **822**, including the screen saver and disconnection events described above. When wireless access to corporate data for a mobile device **816** or **818** has been activated at the LAN **806**, for example when the wireless connector system **828** detects the occurrence of a triggering event for a mobile device user, data items selected by the user are preferably sent to the user's mobile device. In the example of the e-mail message **833**, assuming that a triggering event has been detected, the arrival of the message **833** at the message server **820** is detected by the wireless connector system **828**. This may be accomplished, for example, by monitoring or querying mailboxes **819** associated with the message server **820**, or, if the message server **820** is a Microsoft Exchange server, then the wireless connector system **828** may register for advise syncs provided by the Microsoft Messaging Application Programming Interface (MAPI) to thereby receive notifications when a new message is stored to a mailbox **819**.

When a data item such as the e-mail message **833** is to be sent to a mobile device **816** or **818**, the wireless connector system **828** preferably repackages the data item in a manner that is transparent to the mobile device **816** or **818**, so that information sent to and received by the mobile device **816** or **818** appears similar to the information as stored on and accessible at the host system, LAN **806** in FIG. **8**. One preferred repackaging method includes wrapping received messages to be sent via a wireless network **812** or **814** in an electronic envelope that corresponds to the wireless network address of the mobile device **816** or **818** to which the message is to be

sent. Alternatively, other repackaging methods could be used, such as special-purpose TCP/IP wrapping techniques. Such repackaging preferably also results in e-mail messages sent from a mobile device **816** or **818** appearing to come from a corresponding host system account or mailbox **819** even though they are composed and sent from a mobile device. A user of a mobile device **816** or **818** may thereby effectively share a single e-mail address between a host system account or mailbox **819** and the mobile device.

Repackaging of the e-mail message **833** is indicated at **834** and **836**. Repackaging techniques may be similar for any available transfer paths or may be dependent upon the particular transfer path, either the wireless infrastructure **810** or the wireless VPN router **832**. For example, the e-mail message **833** is preferably compressed and encrypted, either before or after being repackaged at **834**, to thereby provide for secure transfer to the mobile device **818**. Compression reduces the bandwidth required to send the message, whereas encryption ensures confidentiality of any messages or other information sent to the mobile devices **816** and **818**. In contrast, messages transferred via a VPN router **832** might only be compressed and not encrypted, since a VPN connection established by the VPN router **832** is inherently secure. Messages are thereby securely sent, via either encryption at the wireless connector system **828**, which may be considered a non-standard VPN tunnel or a VPN-like connection, for example, or the VPN router **832**, to mobile devices **816** and **818**. Accessing messages using a mobile device **816** or **818** is thus no less secure than accessing mailboxes at the LAN **806** using the desktop computer system **822**.

When a repackaged message **834** or **836** arrives at a mobile device **816** or **818**, via the wireless infrastructure **810**, or via the wireless VPN router **832**, the mobile device **816** or **818** removes the outer electronic envelope from the repackaged message **834** or **836**, and performs any required decompression and decryption operations. Messages sent from a mobile device **816** or **818** and addressed to one or more recipients are preferably similarly repackaged, and possibly compressed and encrypted, and sent to a host system such as the LAN **806**. The host system may then remove the electronic envelope from the repackaged message, decrypt and decompress the message if desired, and route the message to the addressed recipients.

Another goal of using an outer envelope is to maintain at least some of the addressing information in the original e-mail message **833**. Although the outer envelope used to route information to mobile devices **816**, **818** is addressed using a network address of one or more mobile devices, the outer envelope preferably encapsulates the entire original e-mail message **833**, including at least one address field, possibly in compressed and/or encrypted form. This allows original "To", "From" and "CC" addresses of the e-mail message **833** to be displayed when the outer envelope is removed and the message is displayed on a mobile device **816** or **818**. The repackaging also allows reply messages to be delivered to addressed recipients, with the "From" field reflecting an address of the mobile device user's account or mailbox on the host system, when the outer envelope of a repackaged outgoing message sent from a mobile device is removed by the wireless connector system **828**. Using the user's account or mailbox address from the mobile device **816** or **818** allows a message sent from a mobile device to appear as though the message originated from the user's mailbox **819** or account at the host system rather than the mobile device.

FIG. **9** is a block diagram of an alternative communication system, in which wireless communications are enabled by a component associated with an operator of a wireless network.

As shown in FIG. **9**, the system includes a computer system **802**, WAN **804**, a corporate LAN **807** located behind a security firewall **808**, network operator infrastructure **840**, a wireless network **811**, and mobile devices **813** and **815**. The computer system **802**, the WAN **804**, the security firewall **808**, the message server **820**, the data store **817**, the mailboxes **819**, and the VPN router **835** are substantially the same as the similarly-labelled components in FIG. **8**. However, since the VPN router **835** communicates with the network operator infrastructure **840**, it need not necessarily be a wireless VPN router in the system of FIG. **9**. The network operator infrastructure **840** enables wireless information exchange between the LAN **807** and the mobile devices **813** and **815**, respectively associated with the computer systems **842** and **852** and configured to operate within the wireless network **811**. In the LAN **807**, a plurality of desktop computer systems **842** and **852** are shown, each having a physical connection **846** or **856** to an interface or connector **848** or **858**. A wireless connector system **844** or **854** is operating on or in conjunction with each computer system **842** and **852**.

The wireless connector systems **844** and **854** are similar to the wireless connector system **828** described above, in that they enable data items, such as e-mail messages and other items that are stored in mailboxes **819**, and possibly data items stored in a local or network data store, to be sent from the LAN **807** to one or more of the mobile devices **813** and **815**. In FIG. **9** however, the network operator infrastructure **840** provides an interface between the mobile devices **813** and **815** and the LAN **807**. As above, operation of the system shown in FIG. **9** is described below in the context of an e-mail message as an illustrative example of a data item that may be sent to a mobile device **813** or **815**.

When an e-mail message **833**, addressed to one or more recipients having an account on the message server **820**, is received by the message server **820**, the message, or possibly a pointer to a single copy of the message stored in a central mailbox or data store, is stored in the mailbox **819** of each such recipient. Once the e-mail message **833** or pointer has been stored to a mailbox **819**, it may preferably be accessed using a mobile device **813** or **815**. In the example shown in FIG. **9**, the e-mail message **833** has been addressed to the mailboxes **819** associated with both desktop computer systems **842** and **852** and thus both mobile devices **813** and **815**.

As those skilled in the art will appreciate, communication network protocols commonly used in wired networks such as the LAN **807** and/or the WAN **804** are not suitable or compatible with wireless network communication protocols used within wireless networks such as **811**. For example, communication bandwidth, protocol overhead, and network latency, which are primary concerns in wireless network communications, are less significant in wired networks, which typically have much higher capacity and speed than wireless networks. Therefore, mobile devices **813** and **815** cannot normally access the data store **817** directly. The network operator infrastructure **840** provides a bridge between the wireless network **811** and the LAN **807**.

The network operator infrastructure **840** enables a mobile device **813** or **815** to establish a connection to the LAN **807** through the WAN **804**, and may, for example, be operated by an operator of the wireless network **811** or a service provider that provides wireless communication service for mobile devices **813** and **815**. In a pull-based system, a mobile device **813** or **815** establishes a communication session with the network operator infrastructure **840** using a wireless network compatible communication scheme, preferably a secure scheme such as Wireless Transport Layer Security (WTLS) when information should remain confidential, and a wireless

web browser such as a Wireless Application Protocol (WAP) browser. A user then requests, through manual selection or pre-selected defaults in the software residing in the mobile device, any or all information, or just new information, for example, stored in a mailbox **819** in the data store **817** at the LAN **807**. The network operator infrastructure **840** establishes a connection or session with a wireless connector system **844**, **854**, using Secure Hypertext Transfer Protocol (HTTPS), for example, if no session has already been established. As above, a session between the network operator infrastructure **840** and a wireless connector system **844** or **854** may be made via a typical WAN connection or through the VPN router **835** if available. When time delays between receiving a request from a mobile device **813** or **815** and delivering requested information back to the device are to be minimized, the network operator infrastructure **840** and the wireless connector systems **844** and **854** may be configured so that a communication connection remains open once established.

In the system of FIG. **9**, requests originating from mobile device A **813** and B **815** would be sent to the wireless connector systems **844** and **854**, respectively. Upon receiving a request for information from the network operator infrastructure **840**, a wireless connector system **844** or **854** retrieves requested information from a data store. For the e-mail message **833**, the wireless connector system **844** or **854** retrieves the e-mail message **833** from the appropriate mailbox **819**, typically through a messaging client operating in conjunction with the computer system **842** or **852**, which may access a mailbox **819** either via the message server **820** or directly. Alternatively, a wireless connector system **844** or **854** may be configured to access mailboxes **819** itself, directly or through the message server **820**. Also, other data stores, both network data stores similar to the data store **817** and local data stores associated with each computer system **842** and **852**, may be accessible to a wireless connector system **844** or **854**, and thus to a mobile device **813** or **815**.

If the e-mail message **833** is addressed to the message server accounts or mailboxes **819** associated with both computer systems **842** and **852** and devices **813** and **815**, then the e-mail message **833** is sent to the network operator infrastructure **840** as shown at **860** and **862**, which then sends a copy of the e-mail message to each mobile device **813** and **815**, as indicated at **864** and **866**. Information is transferred between the wireless connector systems **844** and **854** and the network operator infrastructure **840** via either a connection to the WAN **804** or the VPN router **835**. When the network operator infrastructure **840** communicates with the wireless connector systems **844** and **854** and the mobile devices **813** and **815** via different protocols, translation operations may be performed by the network operator infrastructure **840**. Repackaging techniques may also be used between the wireless connector systems **844** and **854** and the network operator infrastructure **840**, and between each mobile device **813** and **815** and the network operator infrastructure **840**.

Messages or other information to be sent from a mobile device **813** or **815** may be processed in a similar manner, with such information first being transferred from a mobile device **813** or **815** to the network operator infrastructure **840**. The network operator infrastructure **840** then sends the information to a wireless connector system **844** or **854** for storage in a mailbox **819** and delivery to any addressed recipients by the message server **820**, for example, or may alternatively deliver the information to the addressed recipients.

The above description of the system in FIG. **9** relates to pull-based operations. The wireless connector systems **844** and **854** and the network operator infrastructure may instead be configured to push data items to mobile devices **813** and **815**. A combined push/pull system is also possible. For example, a notification of a new message or a list of data items currently stored in a data store at the LAN **807** could be pushed to a mobile device **813** or **815**, which may then be used to request messages or data items from the LAN **807** via the network operator infrastructure **840**.

If mobile devices associated with user accounts on the LAN **807** are configured to operate within different wireless networks, then each wireless network may have an associated wireless network infrastructure component similar to **840**.

Although separate, dedicated wireless connector systems **844** and **854** are shown for each computer system **842** and **852** in the system of FIG. **9**, one or more of the wireless connector systems **844** and **854** is preferably configured to operate in conjunction with more than one of the computer systems **842** and **852**, or to access a data store or mailbox **819** associated with more than one computer system. For example, the wireless connector system **844** may be granted access to the mailboxes **819** associated with both the-computer system **842** and the computer system **852**. Requests for data items from either mobile device A **813** or B **815** are then processed by the wireless connector system **844**. This configuration is useful to enable wireless communications between the LAN **807** and the mobile devices **813** and **815** without requiring a desktop computer system **842** and **852** to be running for each mobile device user. A wireless connector system may instead be implemented in conjunction with the message server **820** to enable wireless communications.

FIG. **10** is a block diagram of another alternative communication system. The system includes a computer system **802**, WAN **804**, a corporate LAN **809** located behind a security firewall **808**, an access gateway **880**, a data store **882**, wireless networks **884** and **886**, and mobile devices **888** and **890**. The computer system **802**, the WAN **804**, the security firewall **808**, the message server **820**, the data store **817**, the mailboxes **819**, the desktop computer system **822**, the physical connection **824**, the interface or connector **826** and the VPN router **835** are substantially the same as the corresponding components described above. The access gateway **880** and data store **882** provide mobile devices **888** and **890** with access to data items stored at the LAN **809**. In FIG. **10**, a wireless connector system **878** operates on or in conjunction with the message server **820**, although a wireless connector system may instead operate on or in conjunction with one or more desktop computer systems **822** in the LAN **809**.

The wireless connector system **878** provides for transfer of data items stored at the LAN **809** to one or more of the mobile devices **888** and **890**. These data items preferably include e-mail messages stored in mailboxes **819** in the data store **817**, as well as possibly other items stored in the data store **817** or another network data store or a local data store of a computer system such as **822**.

As described above, an e-mail message **833** addressed to one or more recipients having an account on the message server **820** and received by the message server **820** are stored into the mailbox **819** of each such recipient. In the system of FIG. **10**, the external data store **882** preferably has a similar structure to and remains synchronized with, the data store **817**. PIM information or data stored at data store **882** preferably is independently modifiable to the PIM information or data stored at the host system. In this particular configuration, the independently modifiable information at the external data store **882** may maintain synchronization of a plurality of data stores associated with a user (i.e., data on a mobile device, data on a personal computer at home, data at the corporate LAN, etc.). This synchronization may be accomplished, for example, through updates sent to the data store **882** by the

wireless connector system **878** at certain time intervals, each time an entry in the data store **817** is added or changed, at certain times of day, or when initiated at the LAN **809**, by the message server **820** or a computer system **822**, at the data store **882**, or possibly by a mobile device **888** or **890** through the access gateway **880**.

In the case of the e-mail message **833**, for example, an update sent to the data store **882** some time after the e-mail message **833** is received indicates that the message **833** has been stored in a certain mailbox **819** in the store **817**, and a copy of the e-mail message is stored to a corresponding storage area in the data store **882**. When the e-mail message **833** has been stored in the mailboxes **819** corresponding to the mobile devices **888** and **890**, one or more copies of the e-mail message, indicated at **892** and **894** in FIG. **10**, will be sent to and stored in corresponding storage areas or mailboxes in the data store **882**. As shown, updates or copies of stored information in the data store **817** may be sent to the data store **882** via a connection to the WAN **804** or the VPN router **835**. For example, the wireless connector system **878** may post updates or stored information to a resource in the data store **882** via an HTTP post request. Alternatively, a secure protocol such as HTTPS or Secure Sockets Layer (SSL) may be used. Those skilled in the art will appreciate that a single copy of a data item stored in more than one location in a data store at the LAN **809** may instead be sent to the data store **882**. This copy of the data item could then be stored either in more than one corresponding location in the data store **882**, or a single copy may be stored in the data store **882**, with a pointer or other identifier of the stored data item being stored in each corresponding location in the data store **882**.

The access gateway **880** is effectively an access platform, in that it provides mobile devices **888** and **890** with access to the data store **882**. The data store **882** may be configured as a resource accessible on the WAN **804**, and the access gateway **880** may be an ISP system or WAP gateway through which mobile devices **888** and **890** connect to the WAN **804**. A WAP browser or other browser compatible with the wireless networks **884** and **886** may then be used to access the data store **882**, which is synchronized with the data store **817**, and download stored data items either automatically or responsive to a request from a mobile device **888** or **890**. As shown at **896** and **898**, copies of the e-mail message **833**, which was stored in the data store **817**, are sent to the mobile devices **888** and **890**. A data store on each mobile device **888** and **890** is thereby synchronized with a portion, such as a mailbox **819**, of a data store **817** on a corporate LAN **809**. Changes to a mobile device data store are similarly reflected in the data stores **882** and **817**.

The embodiments described herein are examples of structures, systems or methods having elements corresponding to the elements of the invention recited in the claims. This written description may enable those of ordinary skill in the art to make and use embodiments having alternative elements that likewise correspond to the elements of the invention recited in the claims. The intended scope of the invention thus includes other structures, systems or methods that do not differ from the literal language of the claims, and further includes other structures, systems or methods with insubstantial differences from the literal language of the claims.

What is claimed is:

1. A system for determining a status of a digital certificate from status data stored in a status provider system comprising:

a client system comprising a client module, the client module operable to generate and provide status request data corresponding to a status request for the digital certificate for transmission from the client system, and to receive digital certificate status data for the digital certificate in response to the status request; and

a proxy system comprising a proxy module, the proxy module operable to receive the status request data transmitted from the client system and, in response thereto, generate query data for the digital certificate status and provide the query data for transmission from the proxy system to the status provider system, and further operable to receive the status data from the status provider system, generate the digital certificate status data based on the status data received, and provide the digital certificate status data for transmission to the client system;

wherein the client system comprises a mobile device including a memory subsystem and operable to communicate with the proxy system over a wireless network, to receive data items over the wireless network, and to store the data items in the memory subsystem;

wherein the digital certificate status data comprises validity period data indicating a validity period for the digital certificate, and wherein the client module is further operable to periodically generate and provide status request data corresponding to a status request for transmission to the proxy system during the validity period of the digital certificate;

wherein the status request data is generated at the client system at predetermined times spaced at predetermined intervals or at user-configurable intervals; and

wherein the proxy system is operable to redirect a data item to the mobile device, and the proxy module is further operable to determine whether the data item includes a transmitted digital certificate and, upon a determination that the data item includes the transmitted digital certificate, to generate and provide status request data corresponding to a status request for the transmitted digital certificate for transmission to the status provider system, and to receive digital certificate status data for the transmitted digital certificate in response to the status request, and the proxy system is further operable to communicate with a plurality of status providers, thereby allowing the proxy system to redirect data items from the plurality of status providers to the mobile device.

2. The system of claim **1**, wherein the digital certificate status data comprises a subset of the status data received from the status provider system.

3. The system of claim **2**, wherein the status request data comprises a subset of the query data.

4. The system of claim **3**, wherein the query data comprises an Online Certificate Status Protocol (OCSP) query.

5. The system of claim **2**, wherein the digital certificate comprises a digital certificate chain of digital certificates, and wherein the status request data comprises data corresponding to each digital certificate in the digital certificate chain.

6. The system of claim **1**, wherein the digital certificate status data transmitted from the proxy system comprises a valid indicator; a revoked indicator, and an unknown indicator.

7. The system of claim **1**, wherein the digital certificate is used to encode an outgoing message prior to sending of the message from the mobile device.

8. The system of claim **1**, wherein the proxy system is separate from the status provider system.

9. A method for handling digital certificate status request between a client system and a proxy system, the method comprising the acts of:

receiving at the proxy system digital certificate status request data transmitted from the client system;

generating query data for the digital certificate status in response to receiving the digital certificate status request data;

transmitting the query data to a status provider system;

receiving at the proxy system status data from the status provider system in response to the query data;

generating digital certificate status data based on the status data received; and

transmitting the digital certificate status data to the client system;

wherein the client system comprises a mobile device including a memory subsystem and operable to communicate with the proxy system over a wireless network, to receive data items over the wireless network, and to store the data items in the memory subsystem;

wherein the digital certificate status data comprises validity period data indicating a validity period for the digital certificate, and wherein the client module is further operable to periodically generate and provide status request data corresponding to a status request for transmission to the proxy system during the validity period of the digital certificate;

wherein the status request data is generated at the client system at predetermined times spaced at predetermined intervals or at user-configurable intervals; and

wherein the proxy system is operable to redirect a data item to the mobile device, and the proxy module is further operable to determine whether the data item includes a transmitted digital certificate and, upon a determination that the data item includes the transmitted digital certificate, to generate and provide status request data corresponding to a status request for the transmitted digital certificate for transmission to the status provider system, and to receive digital certificate status data for the transmitted digital certificate in response to the status request, and the proxy system is further operable to communicate with a plurality of status providers, thereby allowing the proxy system to redirect data items from the plurality of status providers to the mobile device.

10. The method of claim **1**, wherein the proxy system receives the status data from the status provider system using communication protocols other than Online Certificate Status Protocol (OCSP).

11. The method of claim **9**, wherein the digital certificate status data is a subset of the status data received from the status provider.

12. The method of claim **9**, wherein the digital certificate status request data comprises a subset of the query data.

13. The method of claim **12**, wherein the query data for the digital certificate status comprises Online Certificate Status Protocol (OCSP) query data.

14. The method of claim **9**, wherein the digital certificate is used to encode an outgoing message prior to sending of the message from the mobile device.

15. A system for determining a status of a digital certificate from status data stored in a status provider system comprising:

a client system comprising a client module, the client module operable to generate and provide status request data corresponding to a status request for the digital certificate for transmission from the client system, and to receive digital certificate status data for the digital certificate in response to the status request; and

a proxy system comprising a proxy module, the proxy module operable to receive the status request data transmitted from the client system and, in response thereto, generate query data for the digital certificate status and provide the query data for transmission from the proxy system to the status provider system, and further operable to receive the status data from the status provider system, generate the digital certificate status data based on the status data received, and provide the digital certificate status data for transmission to the client system;

wherein the client system comprises a mobile device including a memory subsystem and operable to communicate with the proxy system over a wireless network, to receive data items over the wireless network, and to store the data items in the memory subsystem;

wherein the digital certificate status data comprises validity period data indicating a validity period for the digital certificate, and wherein the client module is further operable to periodically generate and provide status request data corresponding to a status request for transmission to the proxy system during the validity period of the digital certificate;

wherein the status request data is generated at the client system at predetermined times spaced at predetermined intervals or at user-configurable intervals;

wherein the status request data is generated without requiring receipt of a message at the mobile device; and

wherein the proxy system is operable to redirect a data item to the mobile device, and the proxy module is further operable to determine whether the data item includes a transmitted digital certificate and, upon a determination that the data item includes the transmitted digital certificate, to generate and provide status request data corresponding to a status request for the transmitted digital certificate for transmission to the status provider system, and to receive digital certificate status data for the transmitted digital certificate in response to the status request, and the proxy system is further operable to communicate with a plurality of status providers, thereby allowing the proxy system to redirect data items from the plurality of status providers to the mobile device.

16. A method for handling digital certificate status request between a client system and a proxy system, the method comprising the acts of:

receiving at the proxy system digital certificate status request data transmitted from the client system;

generating query data for the digital certificate status in response to receiving the digital certificate status request data;

transmitting the query data to a status provider system;

receiving at the proxy system status data from the status provider system in response to the query data;

generating digital certificate status data based on the status data received; and

transmitting the digital certificate status data to the client system;

wherein the client system comprises a mobile device including a memory subsystem and operable to communicate with the proxy system over a wireless network, to receive data items over the wireless network, and to store the data items in the memory subsystem;

wherein the digital certificate status data comprises validity period data indicating a validity period for the digital certificate, and wherein the client module is further operable to periodically generate and provide status request data corresponding to a status request for transmission to the proxy system during the validity period of the digital certificate;

wherein the status request data is generated at the client system at predetermined times spaced at predetermined intervals or at user-configurable intervals;

wherein the status request data is generated without requiring receipt of a message at the mobile device; and

wherein the proxy system is operable to redirect a data item to the mobile device, and the proxy module is further operable to determine whether the data item includes a transmitted digital certificate and, upon a determination that the data item includes the transmitted digital certificate, to generate and provide status request data corresponding to a status request for the transmitted digital certificate for transmission to the status provider system, and to receive digital certificate status data for the transmitted digital certificate in response to the status request, and the proxy system is further operable to communicate with a plurality of status providers, thereby allowing the proxy system to redirect data items from the plurality of status providers to the mobile device.

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